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GORBACHEV'S ECONOMIC PLANS

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LETTER OF TRANSMITTAL

SEPTEMBER 14, 1987.

To the Members of the Joint Economic Committee:

Transmitted herewith for use by the Joint Economic Committee, Congress, and the interested public is a study assessing the economy of the Soviet Union entitled "Gorbachev's Economic Plans." The study comprises papers prepared at the Committee's request by government and private sector experts, and is contained in two volumes. This effort is the latest in a series of comprehensive studies of the Soviet Union which are published by the Committee approximately every three years.

The current study focuses attention on the economic plans and other initiatives of General Secretary Mikhail Gorbachev. His proposed reforms constitute the most comprehensive effort to change the Soviet economic system since Lenin introduced the New Economic Program. The reforms, if effectively implemented, could have major ramifications in the short and longer terms for the Soviet Union and also for the United States.

We are grateful to the Congressional Research Service of the Library of Congress for making available the services of John P. Hardt to help plan the study. Dr. Hardt and Richard F. Kaufman edited the volumes. Dr. Hardt was assisted by Jean F. Boone of the Library staff. We are also grateful to the many authors who contributed papers to the study.

It should be understood that the views contained in the volumes are those of the authors and not necessarily those of the Joint Economic Committee or of its individual Members.

Sincerely,

PAUL S. SARBANES,
Chairman.

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GORBACHEV'S ECONOMIC PLANS: PROSPECTS AND RISKS

By John P. Hardt* and Richard F. Kaufman**

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I. Shortcomings of the Soviet System

Mikhail Gorbachev's efforts to revive and modernize the Soviet economy follow what his chief economic adviser describes as 10 to 15 years of stagnation. In his own words, the economy has reached a "pre-crisis" stage. There may be more than a little of politics involved—it is not unusual for new leaders to blame current ills on their immediate predecessors, even and perhaps especially in Communist countries. In this case, there is overwhelming evidence of the shortcomings of the Stalinist system of economic management. The prospects of continued decline in performance and the political imperative for improved performance made the risk of significant change necessary.

1. U.S.-Soviet Comparisons

In past years, Soviet leaders were fond of comparing themselves with the United States and pointing to measures of their more rapid growth. Overtaking the United States and the West once seemed within their grasp. In the wake of the lengthy slowdown of Soviet economic growth, such comparisons must now be disconcerting to Moscow. While the Soviets lead in areas such as energy,

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This paper represents views of the authors and not necessarily those of the Congressional Research Service, the Joint Economic Committee, or the U.S. Congress.

steel, and cement production, its gross national product (GNP) is just over 50 percent of the United States, about what it was in 1960, and per capita GNP and consumption are less than half. (See Table 1.) Consumer standards are far behind the West's and the gap may be growing.

TABLE 1.—U.S. AND U.S.S.R.: MAJOR ECONOMIC INDICATORS, 1985*

	U.S.	U.S.S.R.
GNP (billion U.S. dollars)	$3,990	$2,160
Population (millions)	238.6	278.9
GNP per capita	$16,720	$7,740
Consumption per capita	$11,660	$3,690
Grain output [1]	1,450	680
Meat production [1]	108	61
Oil production [2]	8,933	11,350
Natural gas production [3]	17,220	20,721
Coal production [4]	803.9	648.5
Nuclear power capacity [5]	83.6	28.3
Crude steel production [4]	80.1	155.0
Cement production [4]	72.6	131.0
Textile production [6]	13.3	10.3
Footwear production [7]	300	787
Final machinery output (billion U.S. dollars)	$412	$317
Construction (billion U.S. dollars)	$408	$426
Total freight turnover [8]	3,422	5,774

[1] Kilograms per capita.
[2] Thousand barrels per day.
[3] Billion cubic feet.
[4] Million metric tons.
[5] Thousand megawatts. U.S. figure is on a net basis; Soviet data is gross capacity.
[6] Billion square meters.
[7] Million pairs.
[8] Billion metric ton-kilometers. Includes railroad, motor vehicle, inland water, and air freight as well as petroleum pipelines.

*Data from CIA, Economic Handbooks.

Moreover, the continued reliance on the old extensive growth formula (pouring in more material and human resources for needed output) meant labor and material efficiency would continue to diverge from international standards and capital requirements would continue to rise. The Soviet economy that missed the Second Industrial Revolution (the economic miracles of the West) was paying for their dedication to the Stalinist system with inefficient use of scarce inputs and low quality of output. To compete with the United States, Gorbachev must join the Western pattern of growth to conserve inputs and raise the quality of outputs. Poor quality output in manufacturing, except for military programs, meant that the Soviet Union continued to trade like a developing country—exporting energy and importing manufactured goods. Only in arms sales have they competed in the world market for technologically advanced products.

More important and threatening to the superpower status of the Soviet Union are its lags in technology. Computer applications, micro-electronics, the use of lasers, and robotics are all part of the dramatic changes occurring in the economies of the Western industrial nations. Gorbachev has stressed again and again that the Soviet Union must not fall further behind in this new frontier of science, technology, and economic development, or they will not

only miss entering the world market but may be inferior in the technologically advanced battlefields of the coming decades.

It is estimated that the United States holds leads against the Soviets of from 7 to 12 years in advanced manufacturing categories, such as computer-operated machine tools, minicomputers, mainframes, super-computers, software, and flexible manufacturing systems. These technologies have both military and civilian applications. The Soviet defense burden is estimated at about 15 percent of GNP, more than twice as much as in the United States, yet Soviet military technology continues to lag behind the United States.

2. Soviet Performance

Soviet economic failures are absolute as well as relative. By most measures, performance has been poor since 1975 and getting worse. Average annual growth of GNP was over 4 percent between 1960 and 1975, but only 2 percent from 1975 to 1985. In the five-year period 1981–1985, growth averaged 1.9 percent. During the same period, average net farm output grew by 1.9 percent and industry grew by 2.0 percent. Total factor productivity declined to 0.9 percent in 1981–1985, compared with a growth rate of 1.9 percent in the previous five years.

A number of factors account for the poor performance. Rapid economic growth in the 1950's and 1960's was based largely on large increases in labor and capital. These advantages were lost as the growth of the labor force slowed and the cost of utilizing natural resources increased. Greater investment might have kept up the growth rate of the capital stock, but consumption or defense would have had to be reduced commensurately. Brezhnev tried to reverse the process by improving efficiency and productivity. But the action he took in the 1976–1980 Plan—reducing the growth rate of investment—is widely believed to have been counterproductive.

The inefficiency of the Soviet economic system is illustrated by the difficulties it has in properly exploiting the rich endowment of natural resources and people.

—It is the world's largest producer of energy but uses 2–3 times more energy per unit of economic output than the leading industrial countries.

—It is the world's largest producer of wheat but 20 percent of the crop is lost from field to mill because of inadequate transportation and storage.

—It is one of the world's most populous nations but finds itself short of labor partly because of low productivity.

3. Call for Restructuring

Gorbachev succeeded to power in March 1985 and immediately set about what appears to be a crusade for change and improved economic performance. Beginning with the 12th Five Year Plan (the early drafts of which he reportedly rejected) prepared in 1985 and approved in 1986, and a cross-country speaking tour, in which he called for radical reforms of the economic system, Gorbachev has steadily intensified his rhetoric. He acknowledges that the

Soviet Union would have difficulty simultaneously meeting defense requirements, modernizing industry, and improving living standards without improved economic growth. He is calling for qualitative, in addition to quantitative, improvements. In the area of industrial production, the Soviet leader urges "the structural transformation of the economy." To managers, workers, bureaucrats, and Party leaders alike, Gorbachev has said it is understood that "we cannot live and work in the old way, that we must have renewal and profound transformations."

Perestroika (transformation) is the overall policy of change involving reforms, restructuring, and interdependence, openness, and democratization. This policy, with the application of openness (*glasnost*), has led to vigorous debate among economists in the Soviet press and even more strident calls for reform. Proposals are being offered for fundamentally overhauling and radically changing the economic system of central planning that previously would have been unthinkable or at least unprintable in official organs. The implementation of Gorbachev's reform ideas include use of market prices for determining output and distribution and a shift of management decisionmaking from the central ministries to the enterprises.

The June 1987 plenary meeting of the Communist Party Central Committee strengthened the possibilities of radical reform. Gorbachev went beyond his previous statements in several respects. He proposed greater use of the family contract system in agriculture and called for collective and state farms to turn over to individuals some 800,000 abandoned houses with small holdings. He called for "radical reform of the pricing system," pointing out that the administrative pricing of goods below the cost of production has resulted in rapid growth in subsidies, now in excess of 75 billion rubles a year, and suggesting a framework for partial price decontrol. This shift to the use of monetary over physical directives in management of the non-strategic parts of the Soviet economy is to be accompanied by a shift of managerial decisionmaking authority from central ministries, state committees on planning, supply and construction to enterprises. If brought into force as projected, the staff reductions in the central economic bureaucracy in Moscow would be unprecedented. He also indicated that the government would tolerate some plant closures, bankruptcies of enterprises that cannot meet the test of profit and loss accounting, and a degree of worker dislocation. By the adoption in June 1987 of specific programs for implementing radical reform, rhetoric is being translated into action.

II. Gorbachev's Economic Strategy

After two and a half years in power, Gorbachev's economic strategy can be described as having three dimensions: a change in priorities, steps to make the individuals and institutions in the system work better, and proposals to change the system itself. But when evaluating Gorbachev's strategy, it should be kept in mind that the changes could lead to a worsening of economic performance in the short term and a threat to Gorbachev's position. To succeed, the

changes must be productive. For this to occur, his constituencies must be supportive—even enthusiastic.

1. Changing Priorities

According to the 12th Five Year Plan and related documents, annual GNP growth is supposed to average about 4 percent for 1986–1990, and about 5 percent in 1991–2000. For 1986–1990, agriculture is to increase by 3 percent annually, and industry by 4.5 percent. These growth rate targets are considerably higher than what occurred in the prior decade (GNP growth averaged about 2.3 percent in 1976–1985) and are considered ambitious.

More significant than the macroeconomic targets are the qualitative changes emphasizing new technology requiring a change in priorities. Investment is being increased relative to consumption. Among the recipients of investment, research and development (R&D) and the high technologies industries are favored over chemicals, light industry, and transportation. Some experts believe investment is also being shifted from the defense industries to the civilian sector.

Gorbachev's investment policies have been termed the cornerstone of his "intensification" program to modernize the economy and provide for future higher rates of economic growth. Capital investment is planned to grow substantially more than in the previous 10 years and is to be concentrated on new equipment and renovation of existing facilities. The plan seems to imply rapid growth in the high technology areas of civilian machine-building, little or no growth of military hardware, and slow growth of consumer goods. Investment in agriculture is not being cut back but the composition is shifting toward transportation, storage, and processing of food.

2. Making the System Work Better

Efforts to make the system work better move in several directions. Actions directed at the "human factors" are intended to improve labor productivity. A number of measures have been taken to strengthen Party discipline, get rid of incompetent managers and officials, and improve worker attitudes and behavior. There have been numerous personnel changes at the upper levels of economic management and some officials installed by Gorbachev have already been removed, indicating that the qualifications for holding office go beyond being identified as Gorbachev's appointee. The campaigns against corruption and alcoholism, intended to eliminate waste and inefficiency from theft, absenteeism, and industrial accidents, has been much more vigorous than when pursued by Yuri Andropov, Brezhnev's immediate successor.

Gorbachev has also addressed the "capital factor" in a series of efforts intended to improve capital productivity. A breakdown of total factor productivity shows that it is the capital side that has deteriorated while labor productivity has grown, although at modest rates. The major thrust of Gorbachev's initiatives are contained in his "modernization program," designed to upgrade the country's stock of plant and equipment. To accomplish this, it is planned that capital investment in civilian machine-building will

increase by 80 percent in 1986–1990 over 1981–1985, retirement rates for fixed capital will double, and greater efforts will be made to speed up scientific and technological progress. Production of computers, robots, numerically controlled machine tools, and the like, is supposed to increase greatly. In addition, a new quality control program is being enforced at production facilities. One of the stated goals is to achieve world-level quality manufacturing in many areas by the next Five Year Plan.

3. Reforming the System

Gorbachev's initial proposals for reform seemed designed more to "perfect" the Stalinist system than to change it in a fundamental way. In the light of more recent proposals, it now seems clear that Gorbachev's proposals would, if implemented, radically change the economic system. They would substantially decentralize economic decisionmaking, increase enterprise autonomy, increase the scope of the private economy, partially decontrol prices, reduce or eliminate subsidies, and reduce the size of the bureaucracy. Some agricultural reforms have been made and a partial decollectivization is possible. The scope of the private and cooperative sectors has broadened and they could become dominant in consumer services and some consumer goods sectors.

One of Gorbachev's main objectives appears to be a drastic reduction of economic micro-management from the center. Under this approach, the strategic decisions about the general direction of the economy would be made by political leaders at the top. Responsibility for day-to-day management would be left to lower levels, such as farms and factories. Accordingly, organizational changes are being made to streamline and shrink the bureaucracy, to improve policy coordination, and to reduce direct controls over enterprises. To achieve these aims, superagencies have been created for the agro-industrial complex, machine-building, energy, construction, social development, and foreign trade.

At the same time, there have been new initiatives to transfer more responsibility for management from the ministries to the enterprises. The system of mandatory targets for production at the enterprises is being replaced by one that requires only a portion of production to be delivered to the state. The remainder of production would be used to obtain revenue to fulfill the requirements for self-financing. Under self-financing, state subsidies will be reduced or eliminated and enterprises will be responsible for financing their own operations. Those that are unable to meet their costs from revenues could be terminated. A "wholesale trade" system is being created for the distribution of supplies. Presumably, enterprises will be able to choose their suppliers. Some enterprises are being allowed to trade directly with foreign firms, and to retain part of the foreign exchange earned from exports.

In the agricultural sector, local officials and farms have been given greater control over "above-plan" production—the portion that exceeds mandatory requirements. There has been an expansion of the "family contract" system and greater use is being made of long-term leases of land and machinery to small groups. New legislation substantially expands private-sector provisions of con-

sumer goods and services through self-employment and profit-sharing cooperatives. Reforms of prices, finance, banking, and supply are scheduled to be implemented by 1990.

III. Problems and Unresolved Issues

1. Critique of the Plans and Proposals

It is common for Five-Year Plans to set ambitious growth targets that are beyond reasonable expectations. The Plan for 1986–1990 is considered particularly unrealistic. The principal reason is that the economic inputs—mainly labor and raw materials other than fuel—are expected to grow much more slowly than the planned growth of outputs. How is it possible for the rate of growth of output to exceed the rate of increase of inputs? Only rapid growth of productivity can make up the difference.

It is widely believed that systematic problems in the Soviet economy are responsible for poor productivity. These problems include a bias that favors growth in production over qualitative improvements, and other disincentives for innovations and new technology. Even if radical reforms effectively deal with these problems, it is not likely that the benefits would show up before 1990.

Much of the industrial modernization program is based on ambitious output targets and pressure from above. For example, a system of quality control inspectors independent of enterprises has been established with authority to reject below-standard output. Little attention has been given to the problem of natural resource shortages, inadequate transportation, or the lack of incentives to reward the introduction of innovations. There is an inconsistency between the demands for greater output and, at the same time, higher quality. Upgrading and replacing plant and equipment may slow improvements in growth. Further, the assumption of immediate increases in high-quality machinery appears unrealistic. For these reasons, most experts believe the modernization program will result in increased production of modern equipment, but far short of the stated objectives and not enough to lift the economy to the planned targets.

There are also serious reservations about the reasonse to the "human factors" program. It has been observed that the approach consists of many sticks and too few carrots. Gorbachev is telling the key groups to work harder and rely on a new system of meritocracy—to each according to his contribution—a risky change in the Soviet "social contract." How will the various interest groups, such as Party members, bureaucrats, workers, and peasants, respond to the changes taking place? Will they see themselves as winners or losers? These questions are not easily answered. A review of the "interest groups" may help put the problem in perspective.

2. Constituencies and Interest Groups

Gorbachev calls for a revolutionary transformation in society from "conservatism, inertia, and selfish interests" to "renewal, creativity, and constructive initiative." He implies that this change must take place soon; key Party officials should be advocates of the new thinking by the June 1988 Party Conference and all other

groups should shift to the new thinking by the next Party Congress and new Five-Year Plan in 1990.

In each of the key groups, Gorbachev is seeking to build a constituency for new thinking and transformation. He acknowledges the process of change is extremely complex and members of key groups must weigh their reactions carefully. While there may be broad agreement on the general need for change, many may have reservations about its benefits to both Soviet society and to themselves. Gorbachev's use of the "human factors" centers on labor at the work place—workers and peasants—because their reaction to discipline and incentive policies will be key to attaining planned increases in labor productivity. We take a broader view of group participation and its influence on overall productivity by including the leaders—Party, Ministerial Bureaucracy, Military, Intelligentsia, and Managers, the regional and ethnic minority groups whose contributions will influence the success of Gorbachev's plans, and East Europe.

Brief descriptions of the major interest groups and their concerns over economic reform follow:

1. *Communist Party Officials.*—In the Soviet system, there is a parallel structure of government and Party officials. The *nomenklatura* system ensures Party control of appointments, personnel privileges, and rewards at all levels of Party, government, and enterprise. Gorbachev's efforts to centralize broad policy powers at the upper levels of central Committee and Politburo while decentralizing day-to-day management to the enterprise challenges Party control at the regional and local levels. *Glasnost* is intended to make this key group more responsive in following Gorbachev's policy and more accountable. The rights of Party officials to intervene—"petty tutelage"—in the technical operation of the enterprise is apparently to be restricted. The Party Conference scheduled for June 1988 will reexamine and possibly restructure the role of the Party.

2. *Ministerial Bureaucracy.*—Gorbachev also seeks to reduce micro-management of the enterprises by the government ministries. At the June 1987 plenum, he proposed increasing the authority of enterprises over supplies and workers, and reducing the role of central planning agencies. The process of reorganizing and reducing the ministries has already begun. *Gosagroprom* was formed by merging five agriculture ministries and other government units. The central staff was reportedly reduced by almost one-half. Creation of the Foreign Economic Commission and the granting of authority to various ministries and enterprises to engage directly in foreign trade ended the Ministry of Trade's monopoly in this area. Not only ministries, but also state committees and commissions for planning, supply, construction, and price setting are all to have their management functions sharply reduced in favor of the enterrise. Curtailment of central planning targets, enterprise self-financing, price reform, wholesale trade, and other reforms will effect the role and size of the government bureaucracy.

3. *The Military.*—Gorbachev appears to be continuing the policy begun in 1976 of a slow growth of military spending, and little if any growth in procurement of military hardware. This and other actions indicate that military priorities no longer have overriding

primacy. But the civilian and military sectors could be on a collision course with respect to resource requirements. For the next year or two, defense production demands may be met in existing facilities. The situation could change if decisions are made to undertake major new military initiatives during the next Five Year Plan period (1990–1995). Unless the industrial base is enlarged and modernized by the early 1990's, difficult choices will have to be made between civilian and military needs for resources. Most Western experts believe the military supports the economic reforms on the assumption that there will be no sharp cutbacks in defense budgets and that a stronger economy will permit qualitative improvements in military capabilities.

4. *Managers.*—The promise of enterprise autonomy should be received favorably by managers whose freedom of action and management powers are severely circumscribed in the present system. Under the proposed reforms, managers will share in profits and have more control over workers, sources of supplies, and possibly prices. The proposed election of managers by the workers may also improve worker-management relations and worker morale. But the reforms introduce many areas of uncertainty for managers, including the risk of losing an election, uncertainty of rewards, availability of supplies, losses of subsidies, and possible factory closures.

5. *Intelligentsia.*—Support from the scientists, economists, and cultural elite is important for broad acceptance of Gorbachev's proposals for restructuring. Many in the intelligentsia are encouraged by the idea that rewards should be based on merit. They are also attracted by the policy of openness which permits greater criticism and publication, and promises improved government statistics. But many traditional Marxist-Leninists and the neo-Stalinists are repelled. Residual bitterness over Stalin's purges and resentment over Party power could lead to the opening of old wounds and disputes. There has already been some resurgence of Great Russian chauvinism, anti-minority sentiments, and resistance to anti-Stalinist criticisms. The intelligentsia may be the group most solidly supporting *perestroika* but the group has little institutional power and is often mercurial in its support.

6. *Workers.*—The crackdown on worker discipline and the policies of wage differentiation and quality control, and the possible shut down of inefficient factories, have a positive and a negative side. They may eventually lead to improved productivity, greater individual rewards, and economic expansion. In the short term, they are viewed as threats by many workers. Some have already lost income because of the quality control program. Others fear loss of privileges, housing, and other rights, inequality among workers, and even unemployment. Job security has been one of the claims most valued in the Stalinist system. Eroding the right to work involves some risk. The government promises more and better consumer goods and services but these have yet to be realized.

7. *Peasants.*—Greater use of the contract system, more family farming, and improved incentives could show positive results and gain support among the peasants. But peasants share the workers dislike of change and they distrust government assurances that they will be better off in a new system. Any reduction of subsidies adversely affecting agricultural income is bound to be resented.

8. *Regional Interests.*—Gorbachev's policies seem to favor the western regions of the Soviet Union as opposed to Central Asia, East Siberia, and the Far East. For example, the industrial modernization program defers new construction and emphasizes renovation of existing facilities, most of which are located in the developed, largely Slavic regions of the European Soviet Union. The shift in agricultural investment and the decisions not to go forward with the Siberian River diversion projects and large regional projects such as BAM mean less resources for the Central Asian and eastern regions. Changes in energy and agricultural prices would affect the regional economies of energy-rich West Siberia and the food baskets in the Ukraine and Kazakhstan. In general, Gorbachev's investment policies favor the Slavic over the non-Slavic regions; changing price policy may have a diverse impact.

9. *East Europe.*—Soviet relations with East Europe fall in a gray area between domestic and foreign interests. There has been significant integration between the Soviet and East European economies and Gorbachev advocates closer economic ties. The Soviets import substantial amounts of high technology machinery and equipment from Eastern Europe and the success of Gorbachev's modernization program depends in part on this source of goods. The East Europeans are expected to increase exports of high technology products to pay back the large debts to Moscow, incurred because of Soviet oil deliveries. The East European governments are also under pressure to increase exports to the West to pay their foreign debts. Tensions with Moscow could increase if East European modernization leads to greater trade with the West, unless it becomes possible to increase exports in both directions.

IV. Highlights of Papers

The papers in the two volumes are divided into 10 sections, each beginning with an overview and most are followed by one or more commentaries. The first two sections cover overall policies and recent economic performance. The remaining sections deal with major sectors such as industry, defense, energy, agriculture, and foreign trade. The following is a bird's-eye view of the contents of these sections.

In Section I, Levine provides a description of Gorbachev's program, including the proposals made at the June 1986 plenum. Cohn compares past and present efforts to improve productivity and describes the importance of systemic problems and the role of defense spending in preempting technological capabilities. Hewett, Vanous, and Roberts discuss the key macroeconomic targets in the 1986–1990 Plan. Kreshover examines Gorbachev's economic strategy and the risks attached to the emphasis on investment in machine-building. Nove notes the potential contradiction between the simultaneous pursuit of accelerated growth and reform. Berliner looks at the organizational restructuring of the economy and envisions the possible future emergence of a three-tiered system in which the private sector, state enterprises, and voluntary cooperation would have major roles. Klein and Bond discuss the longer term position of the Soviet bloc in the world economy, while Brainard highlights the need for the Soviets to make more efficient use of foreign im-

ports. Brainard also examines possible Soviet membership in the international trade and finance organizations.

Section II provides statistics and analyses of the major indicators of recent economic performance. Kurtzweg presents the trends in Soviet GNP together with an explanation of the Central Intelligency Agency's method for estimating Soviet GNP. Kingkade profiles recent and prospective trends in the size and composition of the Soviet population, and explains Soviet policies concerning maternity and size of families and public health. Rapaway describes labor force and employment statistics since 1950 and makes projections to the year 2000. Grossman examines the trends in private incomes and outlays in the "second economy."

Section III looks at the industrial sector from the perspective of Gorbachev's modernization program. Leggett discusses the lack of balance and consistency in the investment plans and the options that remain should they fail. Kushnirsky examines the feasibility of industrial modernization and considers the likely consequences for the economy, if its targets are achieved. Pederson assesses the effects of problems in the construction materials industry on the modernization program. Rumer and Vatkin follow a similar approach with respect to the metals industry, and Harris does the same concerning steel production. Two papers, one by Sagers and Shabad, the other by Braithwaite, analyze the petrochemical and chemical industries, and the roles they play in modernization. Hanson considers how modernization may be influenced by a variety of factors: the effects of the personnel shake-out and attempts to improve worker incentives, the influence of possible resource transfers from military production, and the contribution of imports.

Section IV is about the interactions between defense, the economy, and Gorbachev's program of change. Becker inquires into the Soviet leader's dilemma: the perception of a growing military threat from abroad and a faltering economy constrained by a heavy military burden at home. Cooper discerns a policy commitment by Gorbachev to expand cooperation between the defense and civilian production sectors. Deutch's paper looks at recent developments in defense production and the changes in the weapons acquisition process. Feshbach details the effects of under-investment in health care on the military. Matosich investigates the reliability of the residual method for measuring Soviet defense spending. In their commentaries, Michaud, Maddalena, and Barry examine the planned growth of the civil and military machine-building industries, and Marshall criticizes the conventional approach to estimating the Soviet military burden.

Energy and conservation issues are the subject of Section V. Schanz compares the problem of Soviet energy resource management to the situation in the United States. Stern delves into the difficulties of forcasting production of Soviet oil and gas, and makes his own qualified projections. Thornton considers whether electric power capacity will be adequate or constrain economic growth, and the effects of the accident at the Chernobyl nuclear plant. Warner and Kaiser weigh the possibility that expanded coal use might help replace natural gas by the mid-1990's. Bethkenhagen focuses on total energy production trends. Tretyakova and Kos-

tinsky consider prospects for substantial fuel savings through conservation.

The papers in Section VI look at agriculture policy and performance. Gray reviews the 1986 grain harvest, and experience with the collective contract and agricultural reorganization. Doolittle and Hughes evaluate the effects on agriculture performance of reorganization and streamlining of agro-industrial management, the restructuring of investment, and improved economic incentives. Severin studies the livestock sector and the program for increasing per capita meat consumption. Flynn and Severin assess Gorbachev's initiatives to solve the agricultural transportation problem. Lane, Marston, and Welsh compare the nutrient content of the Soviet and U.S. food supplies, and the effects of shortages of quality foods on consumer satisfaction in the Soviet Union. Goodman, Hughes, and Schroeder analyze the reason for low agricultural labor productivity and the outlook for improvements under Gorbachev. In their commentaries, Johnson and Waedekin discuss the likelihood for change over the next few years.

Section VII concerns technology and science policy, specifically the Soviet efforts to engineer the kind of revolutionary change taking place in the West through computers and the information technologies. Cocks argues that the Soviet leadership is following a military model for spurring technological advance in the civilian sector. Judy contrasts the "information revolutions" in the Soviet Union and the United States and describes the limitations inherent in the Soviet system. Goodman assesses the application of computing in selected areas, including industrial modernization, centralized planning, hiring standards, and the military. McHenry reviews the program to incorporate computing in Soviet enterprises begun in 1966 and examines the prospects for improvement as a result of the Gorbachev reforms. Nyren provides a report of the computer literacy program and describes the obstacles to and possibilities of its success. Heymann discusses the Soviet lag in telecommunications and the barriers to modernization.

Section VIII brings together papers on current efforts to improve consumption and introduce new incentives into the Soviet system. Teague surveys Gorbachev's "human factor" policies to achieve higher labor productivity through such measures as tighter discipline and differentiation in pay and bonuses. Schroeder examines the relative backwardness of the services sector and plans for developing it. Blough, Muratore, and Berk assess the steps taken to improve consumer services by expanding opportunities for individual, family, and small group businesses. Heinemeier evaluates the brigade system of labor organization in industry and construction, and its effects. Alexeev describes the housing problem and appraises proposals to solve it. Treml provides an initial assessment of the anti-drinking campaign. Davis' paper is a wide-ranging view of the Soviet health sector and policies and plans under Gorbachev. In commentaries, Granick suggests a way to improve Soviet national income without systemic reform in the sense of greater marketization; Hauslohner takes the position that prospects are good for some of the reforms taken to improve consumption.

Regional development, transportation, and environmental issues are treated in Section IX. Shabad discusses the shift away from Si-

berian and Far Eastern regional development projects toward more effective use of existing industrial capacity in the European portion of the country. Mote sees a retrenchment in Eastern regional projects, such as the Baykal-Amur (BAM) railroad. Hunter and Kontorovich observe a "squeeze" on investment in transportation and the possibility of bottlenecks during 1987–1990. ZumBrunnen provides an overview of Soviet environmental policies, including Soviet-American cooperation, and a breakdown of recent expenditures for environmental protection. Jensen comments that the issue of regional equality seems to be no longer part of any serious agenda.

The final section addresses Soviet trade policy and foreign economic relations. The papers by Bertsch and Heiss discuss U.S. trade policy with the Soviet Union. Bertsch places U.S.-Soviet relations in historical perspective, describes the factors that influence U.S. policy, and speculates about future policy. Heiss examines the trends in U.S.-Soviet trade flows and the possible effects of recent changes in Soviet policies. McIntyre is the author of two papers. One is an analysis of the Soviet Union's hard-currency trade and balance of payments. A second paper explains Gorbachev's reorganization of the trade sector and the efforts to increase relations with Western firms. Lavigne shows how Soviet trade with less-developed countries is being restructured and the increasing importance of economic as opposed to strategic and political interests. Fogarty and Tritle concentrate on Soviet economic assistance to less-developed countries and the pressures on Gorbachev to contain costs. There are three commentaries: Kanet elaborates on Soviet economic relations with the less-developed countries and the place of foreign trade in Gorbachev's plans to revitalize the economy; Wolf relates economic constraints on Moscow to the policy of continued expansion of its empire; Vogel mentions the consequences for East Europe of current Soviet trade policy, and the effects on NATO of U.S. policy toward the Soviet Union.

[Theodore Shabed, contributor to this and previous Joint Economic Committee volumes, died in May 1987. Dr. Shabad, the founder and editor of "Soviet Geography: Review and Translation," was also foreign correspondent and editor for the New York Times. The Committee, the Congress, the profession and his many friends will miss Ted. We like to think he would appreciate these volumes as his ultimate contribution in a long and productive career.]

I. THE AGENDA OF ECONOMIC CHANGE

OVERVIEW

By Herbert S. Levine*

The papers contained in the first section of the current Joint Economic Committee volume on the Soviet economy deal with what can be called Act I of "Gorbachev's Economic Plans." Act II of the drama begins with the remarkable program put forth at the Plenum of the Central Committee of the Soviet Communist Party held on June 25-26, 1987.

Act I

In Act I, covering the period from Gorbachev's assumption of power in March 1985 up to the June 1987 Plenum, initial elements of Gorbachev's economic program were laid out. They consisted of three parts. The first was his policy on economic growth, his call for growth acceleration, a renewal of economic dynamism coupled with modernization and the improvement in quality of output.

A second component of the Gorbachev program was his "people program." It included the stress on discipline and the work ethic, the anti-alcohol campaign, and the massive changes in the personnel of the country's political and economic leadership. In addition, under the policy of *glasnost,* there has been an historically unprecedented increase in the provision of information to the public. It would appear that the new Soviet leaders have come to accept the view that to run an effective modern economy and society, initiative and effort must come from below, people must have a sense of responsibility and must be held responsible for their actions. And for people to act responsibly, they must be given ample and accurate information about the economic and social situations with which they will have to deal.

The third component of the Gorbachev economic program as it developed in the March 1985–June 1987 period concerned changes in the economic mechanism itself. This involved a wide array of issues, discussions, and proposals. The objective was to modernize the economy, to improve its level of efficiency and technology. The core elements were the increase in economic independence and flexibility of enterprises and the development of real incentives in the system that would lead workers and managers to work hard, efficiently, creatively, and honestly. To make it possible for enterprises to operate with greater independence and flexibility, it was recognized that substantial alterations in the structure of planning

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and administrative institutions would have to be undertaken, and the existing systems of supply, finance, credit, and price formation would have to undergo reform. For incentives to be effective, wage differentials would have to reflect productivity differentials; managerial bonuses would have to be tied to profit and quality and delivery obligations; private activity in the provision of consumer goods and services would have to be increased; and a substantial rise in the inequality of income distribution would have to be accepted.

The intensity of the reform discussion, its frankness and boldness, builds through Act I of "Gorbachev's Economic Plans," with marked acceleration in late 1986 and early 1987. Noteworthy here is Gorbachev's speech at the January 1987 Central Committee Plenum, in which he was harshly critical of the Soviet economic system. The final scene of Act II, however, belongs to Nikolai Shmelev, an economist, previously not prominent in the reform discussions, whose article in the June 1987 issue of the literary and public affairs journal *Novyi mir* was a blockbuster of Soviet radicalism, both in the totality of its criticism of the Soviet economic system developed under Stalin, and in its proposals for reform.[1] It rocketed Shmelev, at least for the moment, though to the pinnacle of the reform debate, and even elicited favorable comments from Gorbachev, who though, demurred from some of Shmelev's reform proposals.

Shmelev, in the article, argued bluntly and basically that the Soviet economic system put in place after NEP is fundamentally flawed. It represents, he said, a substitution of an administrative system of economic management for "the Leninist policy of economically accountable socialism."

> Our economy has been ruled for too long by decree instead of by the ruble. So long that we seem to have forgotten that there was a time when our economy was ruled by the ruble, and not by decree, that is, by common sense, and not by arbitrary, theoretical speculation.
>
> I realize I am inviting reproach, but the question is too serious and vitally important to moderate my terms or resort to discreet silences. Unless we admit the fact that the rejection of Lenin's new economic policy (NEP) had the gravest complicating effect on socialist construction in the USSR, we will once again, as in 1953 and 1965, condemn ourselves to half-hearted measures. And half-hearted actions can, as is well-known, sometimes be worse than inaction. The NEP, with its economic incentives and levers, was replaced by the administrative system of management. This system, by its very nature, was unable to concern itself with improving output quality or increasing production efficiency, or with ensuring that the greatest results were achieved for the smallest expenditures. It sought to achieve the necessary quantity—gross output—not in accordance with objective economic laws, but in spite of them. And acting in spite of these laws means at the cost of inconceivably high expenditure of material and—most importantly—human resources.[2]

His proposals for reform range widely and amount to a call for undoing almost all that was put in place since 1928. Some of his key proposals concern changes in Gosplan and the ministries, the system of price formation, the essential role of competition, and the positive function of unemployment in a socialist economy.

With regard to Gosplan, Shmelev charges that it has no time for what in a planned economy should be its major function—strategic

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[1] N.P. Shmelev, "Avansy i dolgi," (Advances and Legacies), *Novyi mir*, 1987: 6 (June), pp. 142-158. Translation in FBIS-SOV-87-117A (Annex), *Daily Report: Soviet Union*, 18 June 1987, pp. 1-20.

[2] FBIS, *op. cit.*, p. 1.

planning. For it spends its time engaged in the everyday running of the economy: "Watching with the utmost vigilance to ensure that shoemakers stitch shoes and pastry-cooks bake pies." [3] He states that Gosplan should set physical targets for at most 250–300 types of strategic output and should distribute investment funds by sectors and republics, on this basis determining the most important national economic proportions.

He states that ministries are too numerous and their staff so overblown that they have to find things to do, thus hampering the work of the enterprises. This situation requires a speedy radical solution. He quotes Lenin: "In our country everything is swamped in a foul bureaucratic morass of 'departments.' Great authority, intelligence, and strength are needed for the day-to-day struggle against this." [4]

The system of price formation, Shmelev writes, must be fundamentally changed. Prices should reflect market conditions and not be set by people in central offices.

> The voluntarist pricing decisions which have accumulated since the late twenties are a really terrible legacy. Unless we put an end to them we will never have objective cost guidelines for an undisputed comparison of the costs and results of products, not depending on human arbitrariness. And, therefore, we will never have true economic accountability. In today's theoretical debates various projects for transforming the price system are being put forward. However, the majority of these projects contain one common defect, a defect which, judging by our experience, is extremely dangerous: it is proposed that prices will once again be formed in armchairs, once again through theoretical speculation, divorced from life and from the real processes both in our economy and in the world economy.[5]

He goes on to argue that subsidies on wholesale and retail prices must be removed, so that managers operating on profit incentives in markets for producers' goods and workers spending their incomes in markets for consumers' goods will make decisions that are economically rational.

For prices to be effective, for decisions by managers and consumers about what to buy to be meaningful, buyers must have choices, there must be competition in the market. The dominance of the producer over the customer must be broken. Moreover, competition is necessary to force producers to produce products of desirable quality and to pursue technical change.

> We should finally stop deceiving ourselves, stop believing the armchair ignoramuses, and calmly acknowledge that the problem of "choice for the (customer)," the problem of competition, has no social class undercurrents. This has nothing to do with ideology. It is a purely economic, even technically economic problem. Choice, competition—that is an objective condition without which no economic system can be viable or at least sufficiently efficient. Universal shortages, the diktat of the producer—that is not the kind of economic atmosphere in which producers will seek new technical solutions themselves, rather than under the whip. Any monopoly inevitably leads to stagnation, and absolute monopoly to absolute stagnation.[6]

The most controversial part of Shmelev's article, and the part from which Gorbachev publicly demurred, concerns Shmelev's ideas on the positive functions of unemployment in a socialist economy. He begins by arguing that unemployment of a frictional type

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[3] *Ibid.*, p. 11.
[4] *Ibid.* In an astounding demonstration of Soviet literary openness, Shmelev continues the quote from Lenin: "Departments are shit; decrees are shit."
[5] *Ibid.*, p. 12.
[6] *Ibid.*, p. 15.

already exists in the Soviet economy, at 2-3 percent of the labor force. Second, in order for an economy to develop effectively, labor has to be moved from declining industries to new and expanding industries. Thus, where unneeded, labor should be dismissed, and retrained and reallocated to where it is needed. Third—the controversial part—Shmelev argues that the threat of being fired from his job is necessary to get a worker to work hard. Economic coercion must be substituted for administrative coercion.

> Third, let us not close our eyes to the economic harm done by our parasitical confidence in guaranteed work. Today it is, I believe, clear to everyone that we owe disorderliness, drunkenness, and shoddy work largely to excessively full employment. We must discuss fearlessly and in businesslike terms what we could gain from a comparatively small reserve army of labor, an army not, of course, left by the state entirely to the mercy of fate. I am talking about replacing administrative coercion with purely economic coercion. A real danger of losing your job and going onto a temporary allowance or being obliged to work wherever you are sent is a very good cure for laziness, drunkenness, and irresponsibility. Many experts believe that it would be cheaper to pay an adequate allowance to people temporarily unemployed in this way for a few months than to keep in production a mass of idlers who fear nothing and who can (and do) wreck any economic accountability and any attempt to improve the quality and efficiency of social labor.[7]

Thus, by June 1987, the Soviet discussion of economic reform had come a long way from the beginning of Gorbachev's administration in March 1985. What was missing, however, as several of the papers that follow point out, was a broad, comprehensive program to reform the economic system. The outlines of such a program were provided at the June 1987 Party Plenum and the meeting of the Supreme Soviet that followed it.

Act II

In Act I, the playwright identified the problems of the Soviet economy and described the approaches to a policy of reform that were developed during the first two years of the Gorbachev era. The Act I curtain came down on the crescendo of the January 1987 Plenum and the Shmelev *Novyi mir* article.

The curtain to Act II rises on the June 1987 Plenum. Since this overview is being written the week after the Plenum, what follows is a very preliminary description of the comprehensive program of economic reform that is being forged by the Soviet leaders.[8]

The outlines of the reform program are contained primarily in the two documents, "Basic Provisions for the Radical Restructuring of Economic Management," and the "Law on the Enterprise," discussed and endorsed by the June Party Plenum and the meeting of the Supreme Soviet. The essential character of the program is a dramatic move toward economic decentralization which is to be in place for the beginning of the 13th Five Year Plan in 1991. Its highlights consist of the virtual abolition of the annual plan and its obligatory targets, significant independence of enterprise behavior

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[7] *Ibid.*, p. 9.

[8] The description is based on Western newspaper reports, an initial reading of the "Basic Provisions for the Radical Restructuring of Economic Management," *Pravda*, June 27, 1987, press interviews of Aganbegian and Abalkin, *New York Times*, June 27, 1987 and July 4, 1987, and discussions with Soviet economists at the 12th SRI-IMEMO Conference, Menlo Park, California, July 6-8, 1987, and at the 3rd SSRC Workshop on Soviet and East European Economics, Georgetown University, July 13, 1987.

based on the pursuit of profit, flexibility in the allocation of labor, and the reform of prices and the system of price formation.

Starting in 1991, Gosplan is no longer to construct an annual plan. Each enterprise will draft and confirm its own annual plan (and Five Year Plan) based on control figures and long-term economic norms, and state orders (*goszakazy*) for products of critical importance to the economy and national defense.

Apparently there was strong debate about whether to have Gosplan construct and issue control figures as guidelines to enterprises in their construction of their plans. For, though the control figures are not to be obligatory for the enterprises, there is always the danger that they will become so. Furthermore, giving Gosplan the labor intensive task of constructing annual control figures limits the extent of possible reduction in the Gosplan staff.

The role of the *goszakazy* is very interesting. V.S. Nemchinov, the highly respected dean of Soviet economists in the 1950s and early 1960s (and who is referred to in Gorbachev's speech at the June Plenum), wrote several articles in 1964 proposing the abolition of the annual plan and replacing it with a system wherein Gosplan would announce the government's desire to buy stated quantities of certain key products and enterprises would bid for these contracts, competing on the basis of cost, quality, delivery time, etc. In this way, the state would continue to retain central control over the output of key products, but would also stimulate competition leading to cost reduction and improved quality. The role of state orders in the Basic Provisions is similar to the Nemchinov scheme. They are to cover about 25 percent of output. In the beginning, they will be obligatory, because until price proportions become properly aligned, the production of some of these products may not be very profitable and thus many not solicit sufficient bids from producing enterprises to meet the needs of the economy. In addition, the *goszakazy* provide a convenient bridge from the old system with an obligatory annual plan to the new system without an obligatory plan. Since, in the initial transition period, the state orders will be obligatory, there is more assurance that the products of greatest importance to the state will be produced in the quantities desired by the state. The danger, of course, is that the *goszakazy* will remain obligatory.

Enterprises are to be independent and responsible for the results of their activity. Out of the revenue they earn, they are to pay wages and salaries and provide for capital investment (full cost-accounting and self-financing). Investment funds will be augmented by expanded access to bank credit. Financing through the state budget will, as a rule, be excluded, retained only for the largest investment projects. Thus, the main incentive of the enterprise is to be the pursuit of profit.

To enable enterprises to operate decentrally, and to eradicate the prevalent "dominance of the supplier," the existing system of centralized supply will be abolished. Enterprises will be able to purchase the material and equipment they require through their free choice of suppliers—either directly from producers or from wholesale outlets (which will operate on a cost-accounting *(khozraschet)* basis).

Enterprises will have more freedom in setting the size of their own wage funds and labor force. They will be able to dismiss workers, both because of poor work and because the workers are no longer economically needed. And the enterprises will be freed from the need to find new jobs for the dismissed workers. This and the provision of any needed retraining will be the responsibility of the state.

Enterprises will also have the "right" to go bankrupt. Those that chronically lose money will be merged with more successful enterprises, or may be shut down, their workers being redistributed to where they are needed.

In light of the changes in the nature and role of the plan, and the independence of the enterprise, the size and function of Gosplan and the ministries will change. Their staffs will be reduced and they are to focus their attention on long-term growth and investment strategy, technological progress, and interbranch coordination and cooperation, rather than the day-to-day operation of the economy.

The linch-pin of the comprehensive program of fundamental restructuring of the economic mechanism is the reform of prices and the system of price formation. First of all, prices are to reflect the "socially necessary" expenditures on the production and sale of goods, their consumption characteristics and quality, and the effective demand for them. That is, they are to reflect supply and demand. Prices are to cover payments for capital stock, labor and natural resources, and expenditures on environmental protection. The proper relationships among different types of prices are to be put into effect. These include the relationship among wholesale prices, procurement prices, retail prices, and wage rates; and that between prices of raw material products and manufactured products. Subsidies are to be phased out and thus prices of raw material goods will rise relative to manufactured goods. This will involve the gradual increases in consumer prices. It was stated, however, that this will not be permitted to lead to a decrease in the standard of living of workers. What is intended, probably, is the use of cost-of-living wage supplements as has been done in some East European countries and China.

Secondly, the system of price formation will be significantly decentralized. A three-tier system will be used: centrally fixed prices, contract prices allowed to fluctuate within established limits, and freely-fluctuating contract prices. The share of centrally fixed prices is to be sharply reduced covering only the most essential producers' goods and consumers' goods. Contract prices are to be negotiated between sellers and buyers. The Basic Provisions include a statement of the necessity of substantially enhancing the role of users in the determination of prices, thus again emphasizing the need to alter the balance of market power in the Soviet economy between sellers and buyers if the reform program is to succeed.

Finally, the June Plenum formally laid out a timetable for the introduction of the various elements of the reform program. In general, the new system is to be in place for the beginning of the 13th FYP in 1991. The Plenum warned that it is impermissible for a lack of reliable organization, slowness, and absence of coordination, to lead, as in the past, to delays and incomplete implementation of

the reform. Furthermore, the Plenum stated that all existing laws and regulations that conflict with the Basic Provisions and the Law on the Enterprise will be revised and revoked, and that any enterprise activity not specifically prohibited by law will be considered to be permissible. The latter clearly is aimed at preventing the ministries from doing what they did with the 1965 reform, namely issuing regulations for the enterprises that conflicted with the reform thus contributing to its failure.

Let me close this brief discussion of the opening scene of Act II of "Gorbachev's Economic Plans," and its dramatic introduction of a program of radical economic reform, with a few comments on the process of reform and the barriers to its success. Soviet leaders are drawing on ideas that began to develop in the Soviet Union at the end of the 1950s, with the mathematical revolution in Soviet economics, the work of Nemchinov and Kantorovich, and the view that economics is a science of constrained maximization and the economy should be decentralized with enterprises pursuing profits in a competitive environment with prices accurately reflecting (marginal) costs and benefits. The current principal economic advisers to the Soviet leaders were then in their formative years, as were the current Soviet leaders.[9] Gorbachev, in his speech at the June Plenum, complained of the loss of twenty years in his reference to Nemchinov's call for economic reform in the mid-1960s. But such a delay in the introduction of new ideas is to be expected.

The analogy to the famous last section of Keynes' *General Theory* is compelling. The words written by Keynes during the capitalist crisis of the 1930's are strikingly apt for the socialist "precrisis" (Gorbachev's phrase) of the 1980's.

> Is the fulfillment of these ideas a visionary hope? Have they insufficient roots in the motives which govern the evolution of political society? Are the interests which they will thwart stronger and more obvious than those which they will serve?
>
> . . . if the ideas are correct . . . it would be a mistake, I predict, to dispute their potency over a period of time . . . the ideas of economists and political philosophers, both when they are right and when they are wrong, are more powerful than is commonly understood. Indeed the world is ruled by little else. Practical men, who believe themselves to be quite exempt from any intellectual influences, are usually the slaves of some defunct economist . . . I am sure that the power of vested interests is vastly exaggerated compared with the gradual encroachment of ideas. Not, indeed, immediately but after a certain interval; for in the field of economic and political philosophy there are not many who are influenced by new theories after they are twenty-five or thirty years of age, so that the ideas which civil servants and politicians and even agitators apply to current events are not likely to be the newest. But, soon or late, it is ideas, not vested interests, which are dangerous for good or evil.[10]

Part I of the JEC Volume

The papers, by specialists on the Soviet economy, included in Part I of the current volume, are focused on the discussions and programs in Act I of "Gorbachev's Economic Plans." They provide the background for Act II, and anticipate a number of the approaches presented in Act II, Scene I. They can roughly be put into

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[9] For example, Aganbegian, who is now 54, moved to Novosibirsk and began working with Kantorovich in 1961. See P. Taubman, "Architect of Soviet Change," *New York Times*, July 10, 1987, p. D3.

[10] J.M. Keynes, *The General Theory of Employment, Interest and Money*, New York: Harcourt, Brace and Company, (1936), pp. 383–384.

two groups. The first three papers examine the internal and external environment for the performance of the Soviet economy in the period of the 12th FYP 1985–90 that affect the feasibility of the plan. The second three papers are generally concerned with aspects of Soviet economic reform discussions and programs put forth in the first two years of the Gorbachev regime.

The paper by Hewett, Roberts, and Vanous uses an econometric model to explore the feasibility of some key targets in the 12th FYP, focusing in depth on the structure of investment, shifts in investment policy, and consistency at the macro-level. It argues that while overall investment is too low, investment in some sectors is too high, and the demand for machinery exceeds its supply. An alternative, more likely investment pattern is presented and its implications traced with the findings that the demand for machinery remains greater than supply, thus indicating a serious flaw in the plan. The Klein and Bond paper presents a brief summary of the prospects for the world economy over the next few years, prospects they regard as somewhat optimistic. The Soviet economy will be negatively affected by low energy prices, but positively affected by the general revival of world trade, and lower grain prices. Low interest rates will also help. Soviet creditworthiness is high and could support an increase in debt if the Soviets decided to do this. The paper by Brainard is a very thorough discussion of Soviet past, present, and possible future international financial policy. The paper examines financial innovations in the West and in other socialist countries. In particular, it looks at the trend toward financial integration in the West and the decrease in financial regulation by Western governments. It concludes, however, that despite increasing demands for foreign capital, changes in Soviet financing policy are likely to be evolutionary in nature rather than radical. Since the productivity of foreign capital in the domestic Soviet economy remains far below potential, the issue of domestic economic reform to raise its productivity has higher priority, he argues, than does increased and innovative participation in western financial markets.

In the second group, Berliner examines Gorbachev's plans for organizational restructuring of the Soviet economy. In the state sector, the redistribution of authority between senior and junior organizations is to be governed by the principle that the senior organization should concentrate on long-run strategic planning, while the junior organization should be free to operate independently in its realm of responsibility. Though Gorbachev is energetic in support of such organizational changes, Berliner does not see any compelling reason why there should be more success than in the past. The encouragement given to the private sector, however, does substantially exceed that in the past. Berliner then speculates about the development of a Soviet three-sector model—the state, household, and private sectors—and examines its possible operation. Kreshover, in his paper, discusses Gorbachev's developing game plan. He argues that a consistent plan of actions had not, by the end of 1986, been developed. Policies unveiled to that date were largely repeats or extensions of past ideas with a fair amount of improvisation. Kreshover goes on to say rather presciently that Gorbachev probably hopes to have a comprehensive and detailed game plan in

place by the end of the decade to be implemented during the 13th and 14th FYP periods, and that he is keeping his options open for a radical reform should he view it as necessary and feasible in the future. In the final paper, Cohn concentrates on Gorbachev's intensive economic development strategy. He discusses the difficulties of modernizing the Soviet capital stock, pointing out the reasons for low rates of capital retirement (e.g., managerial incentives biased toward meeting current output targets) and impediments to renovation of capital equipment (e.g., structures, built for durability, which are difficult to alter when required for retooling). Moreover, the fundamental problem of the slow pace of Soviet technological progress is compounded by the priority given to defense. In fact, Cohn argues, the main burden of defense has been its preemption of the economy's technological capabilities.

SOVIET INTENSIVE ECONOMIC DEVELOPMENT STRATEGY IN PERSPECTIVE

By Stanley H. Cohn*

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SUMMARY

Traditional Soviet economic development strategy has stressed the rapid infusion of labor, capital, and material inputs into industrial production. It placed much less effort on raising the productivity of existing and new assets. With the depletion of the manpower reservoir, it has led to falling growth rates over the past quarter century.

The Soviet leadership has belatedly recognized the imperative to stress productivity advances as the solution to reverse the trend toward stagnation, a policy termed "intensive development" in official jargon.

While central planning with its tight control over resource allocation has enabled the Soviet economy to attain higher rates of saving and investment than in market economies with equal per capita incomes, such forced saving has not been matched by equal returns on investment. Soviet capital productivity trends had been inferior to those of market economies. The system has failed to provide the incentives needed for efficient resource utilization.

Since the regime has been reluctant to reduce high defense priorities, the new strategy must be supply oriented. The focus of intensive development is upon investment and technology policies.

Performance to date of the new strategy has been disappointing. Accelerated depreciation guidelines have not been followed, largely because managerial incentives are still biased toward maximization

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of current ouput. While the replacement share of investment has been rising, it has fallen woefully short in its botton line objective of accelerating growth in capital productivity.

One inhibiting factor has been the inflexible nature of Soviet construction technology. While the emphasis of replacement investment is upon large savings in construction costs, some alteration of factory buildings is required, but these have been costly and constrained because of the Soviet preference for heavy prefabicated concrete structures and the use of overhead bridge cranes. Furthermore, the construction sector has not been organized to provide the specialized services required for replacement investment.

Of even greater importance has been the inability of Soviet R & D and industry to support the necessary pace of technological progress. The Soviet system is lacking in the supplier and consumer initiative so essential for technological advancement. Supplier initiative suffers from the institutional separation betweeen R & D and production and consumer initiative from the chronic seller's market.

These systemic deficiencies are compounded in their impact by the superior priorities accorded to defense. The main burden of defense has been its preemption of the economy's technological capabilities. Prospects for the successful implementation of the new strategy are dimmed by the continuing overriding defense priorities with their rising technological intensity, alongside of a similar technological imperative for investment.

Even if priorities could be redirected toward investment, achievement would continue to be stymied by the institutional constraints of centralized planning. Perceptive Soviet economists have voiced similar conclusions. The pronouncements and actions of Gorbachev have been too traditional to significantly raise productivity performance.

More fundamental reforms in East Germany and even more sweeping precedents in Hungary and China have yielded impressive productivity accomplishments. In the latter two cases reforms have led to introduction of market type mechanisms and decentralization of production decisions within a socialist framework. So far, Soviet leaders have been loathe to abandon traditional planning practices.

Traditional Soviet Development Strategy

As both Soviet and Western observers of Soviet economic development have repeatedly said,[1] the traditional Soviet approach to growth has stressed the rapid infusion of labor, fixed capital, and raw materials into industry. Compared with the path followed by industrializing market economies, there has been proportionately far less effort to increase the productivity of either existing or new manpower and capital assets. Since 1960, the USSR—among the major industrial economies—has experienced the most rapid growth of employment and, along with Japan, the fastest growth of fixed capital stock. In sharp contrast, the Soviet Union has shown

[1] E.g., Abram Bergson, "Toward a New Growth Model", *Problems of Communism*, Mar.-Apr. 1973, pp. 1-9. T. Khacheturov, *The Economy of the Soviet Union Today*, Progress Publisher, 1977.

the lowest rate of increase in both labor and capital productivity (table 1).

TABLE 1.—REAL GROSS PRODUCT, FACTOR INPUTS, AND PRODUCTIVITIES

[Average annual percentage rates of change, 1960–73 and 1973–78]

	Real gross product	Factor inputs			Factor productivities		
		Total	Labor	Capital	Total	Labor [1]	Capital [2]
United States:							
1960 to 1973	4.4	2.3	1.3	4.1	2.1	3.1	0.3
1973 to 1978	2.9	2.3	1.5	3.6	.6	1.4	−.7
Japan:							
1960 to 1973	10.8	4.7	.9	12.2	6.1	9.9	−1.4
1973 to 1978	3.8	2.5	.2	7.2	1.3	3.6	−3.4
United Kingdom:							
1960 to 1973	2.9	.8	−.9	3.9	2.1	3.8	−1.0
1973 to 1978	.4	.1	−1.0	4.7	1.8	4.0	−1.7
France:							
1960 to 1973	5.8	1.9	−.1	5.1	3.9	5.9	.7
1973 to 1978	3.0	1.2	−1.0	4.7	1.8	4.0	−1.7
West Germany:							
1960 to 1973	4.6	1.4	−1.2	6.2	3.2	5.8	−1.6
1973 to 1978	1.8	−.1	−2.4	4.1	1.9	4.2	−2.3
Italy:							
1960 to 1973	5.6	0	−2.2	4.7	5.6	7.8	.9
1973 to 1978	2.1	1.9	1.2	3.3	.2	.9	−1.2
U.S.S.R.:							
1960 to 1973	5.2	3.6	1.4	8.8	1.5	3.7	−3.2
1973 to 1978	3.6	3.3	1.3	8.1	.3	2.3	−4.5

[1] Defined as output per man years of employment in business sectors of market economies and non-service sectors of the Soviet economy.
[2] Defined as output per unit of fixed business capital in market economies and per unit of productive capital stock in the Soviet economy.

Sources: Market economies—Estimates of John W. Kendrick prepared for the New York Stock Exchange study, "U.S. Economic Performance in a Global Perspective," 1981.
Soviet Union—Manhours: Stephen Rapawy, "Civilian Employment in the USSR, 1950–1978," Foreign Demographic Analysis Division, Bureau of the Census, Feb. 1980.
Capital: Stanley Cohn, "Sources of Law Productivity in Soviet Central Investment", in compendium of Joint Economic Committee, "Soviet Economy in the 1980s: Problems and Prospects," 1982. Author's unpublished appendixes A and B.
Production: Central Intelligence Agency, Net Foreign Assessment Center, "Handbook of Economic Statistics," 1982.

In official Soviet jargon the traditional approach is termed "extensive" and the alternative path of stress upon productivity as "intensive". While Soviet planners have continually accorded lip service to productivity objectives under the rubric of "hidden production reserves", they have embraced intensive development as a major policy focus only within the past decade.

The historic preference for extensive development can be explained both in terms of resource endowment and institutional factors. Until the 1960's the Soviet economy could draw upon an unusually large pool (by international experience) of underemployed agricultural labor. The mere movement of a worker from rural to industrial employment resulted in a doubling of annual manhours of labor effort. The vast migration to the urban work force was reinforced by the success of the system in inducing its female population to seek employment in urban areas. The Soviet labor participation ratio (employment as a proportion of working age population) is considerably higher than those in the major market economies.

The high rate of growth of productive capital stock was achieved by high rates of increase in fixed capital investment, which in turn was made possible by a high national savings rate. By its control

over resource allocation the Soviet government forced the population to save a much higher share of national income than would have prevailed under consumer sovereignty. In national account statistics, forced saving is reflected in the high share of investment and relatively low share of personal consumption in GNP. If the Soviet investment effort is assessed according to the usual finding that the national propensity to save is directly proportional to an economy's per capita GNP, the degree of forced saving is graphic. While the Soviet investment/GNP ratio is second only to that of Japan, its per capita GNP level is the lowest of any of the major industrial economies (table 2).

TABLE 2.—COMPARATIVE INVESTMENT EFFORTS

Country	Per capita GNP [1]	Fixed investment/ GNP [2]
United States	8,089	18.2
Germany	6,876	23.6
France	6,679	21.6
Japan	5,735	32.0
United Kingdom	4,990	17.8
Italy	4,667	20.0
U.S.S.R.	3,964	26.0

[1] 1980 dollars.
[2] Percentage.

Sources: Per Capita GNP.—R. Summers, A. Heston, "Improved International Comparisons of Real Product and Its Composition, 1950–1980", "Review of Income and Wealth," June 1984, pp. 259–60.
CIA, "Handbook of Economic Statistics," p. 62.
Investment/GNP Ratios—OECD, "Historical Statistics, 1960–1980," p. 60.
CIA, "Handbook of Economic Statistics," Figure 2.

The favorable consequences of high rates of investment for growth were reinforced by an investment policy that favored heavy industry and energy, with minimal shares directed to the consumer-oriented sectors of light industry and housing. The stress on industrial investment, however, was accompanied by underinvestment in the complementary transportation sector. Even from the narrow perspective of planners' priorities, this neglect was shortsighted and required urgent rectification by the late 1970's.[2]

Finally, the impact of the strenuous investment effort on economic growth was intensified by maximizing the rate of *net* investment. Active lives of productive assets have been unusually long by market economy experience. Obsolescent machinery and equipment have been retained in production through large and wasteful outlays on capital repairs.[3] Thus, the overwhelming portion of investment in new equipment has been directed into new plant or expansion of existing plant capacity, rather than into replacement of obsolescent assets.

Wisely, Soviet planners realized that large physical investments had to be accompanied by investment in human capital. The USSR first eliminated mass illiteracy, then proceeded to overtake and surpass Western Europe in terms of providing access to both sec-

[2] Gertrude Schroeder, "The Slowdown in Soviet Industry, 1976–1982", *Soviet Economy*, January–March 1985, pp. 61–64.
[3] Stanley Cohn, "Sources of Low Productivity in Soviet Capital Investment", contribution to Joint Economic Committee compendium, *Soviet Economy in the 1980s: Problems and Prospects*, Part I.

ondary and higher education. As with physical investment, investment in human capital was structured so as to have a maximum impact on industrial production. At all levels of education Soviet schools emphasize instruction in mathematics, science, and engineering. The high priority to education resulted in a rapid increase in the quality of the Soviet labor forces.

The extensive approach to development is integral to Soviet central planning. Central planning is essentially an arrangement for resource mobilization rather than for efficient resource utilization. The system originated as the mechanism for implementing Stalin's program of frenetic industrialization during the first three prewar Five Year Plans (1928–1941). It has continued with little alteration since that period. The system was later adopted by the socialist economies of Eastern Europe, East Asia, and Cuba during their initial years of Communist rule.

While the planning authorities have direct control over the allocation of labor, education policy, and the rate and structure of investment, they must rely upon plant managers to organize labor and plant and equipment so as to maximize their productivity. They must rely also upon scientists and engineers to develop and apply the new technologies, which are the keys to productivity gains.

But central planners have not succeeded in devising a system of incentives to elicit high productivity performance from managers.[4] Neither have they devised appropriate institutions and incentives to generate the requisite flows of advance technology from research and development organizations or efficient application of R&D by industrial ministries and managers.[5] Socialist reformers in Eastern Europe and China have found it necessary to introduce market decision mechanisms and institutional decentralization in order to implement intensive development policies.

New Strategy Imperative

The traditional extensive growth strategy was yielding diminishing growth in the USSR by the 1970's and threatening stagnation by the 1980's. Sharply reduced birth rates, the exhaustion of the rural labor reservoir, and the approaching ceiling in the female labor participation ratio combined to result in much lower employment growth rates (table 3). With the attainment of universal secondary education and little expansion slated for elitist university education, the rate of increase in human capital also declined. This trend was further strengthened by the decline in the size of Soviet youth cohorts.

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[4] Joseph Berliner, *The Innovation Decision in Soviet Industry*, MIT Press, 1976.

[5] R. Amman, J.M. Cooper, *Industrial Innovation in the Soviet Union*, Yale University Press, 1982.

TABLE 3.—U.S.S.R. GROWTH OF GNP, FACTOR INPUTS, AND FACTOR PRODUCTIVITY

[Annual average percentage change]

	1966–70	1971–75	1976–80	1981–82
Gross national product	5.3	3.7	2.7	2.1
Combined inputs	4.1	4.2	3.6	3.2
Manhours	2.0	1.7	1.3	1.1
Capital	7.4	8.0	6.9	6.4
Total factor productivity	1.1	−.5	−.8	−1.0
Manhour productivity	3.2	2.0	1.3	1.1
Capital productivity	−2.0	−4.0	−4.0	−4.0

Source: Joint Economic Committee, "Hearings on the Allocation of Resources in the Soviet Union and China—1983," 20 September 1983.

Rates of growth of plant and equipment also fell sharply. Even though the investment share of GNP continued to rise gradually, falling GNP growth rates necessarily led to declining growth rates for all resource claimants, including investment. Efforts to sustain earlier rates of growth by investment under such circumstances would have led to rapidly diminishing returns. Even with large reductions in investment growth rates, investment-output (GNP) ratios still rose significantly, alarming Soviet economists and planners. By Soviet measurements the return on investment has fallen by half in the past 30 years and by a third in the past decade.[6]

Slowing growth of factor inputs is typical of the industrialization process. It has occurred generally in market economies with the onset of industrial maturity. What is unusual in Soviet performance is that productivity fell from levels that were below those in market economies at similar stages of economic development. Market economies have managed to offset reduced factor availabilities with improved, or at the very least, unchanged productivity performance.

During the remainder of the century demographic influences promise even more drastic declines in additions to the labor force.[7] With the easy gains already attained, human capital will increase at much lower rates. There is little margin to raise the investment share of GNP because consumption cannot be squeezed further without hurting productivity and because the leadership is reluctant to sacrifice the high priority given to defense. Rather, capital stock is likely to grow more slowly with implementation of such declared policy objectives as shorter asset lives and a rising proportion of replacement investment.

The leverage available to the Soviet leadership is therefore the same as that available to and pursued by market economies—to focus on productivity. Thus, the intensive approach to development has become the dominant path.

Intensive Development Policies

The new approach to sustained development has thus far preserved existing resource priorities. There has been some slippage in the share of personal consumption share of GNP in the 1980's, al-

[6] V.I. Kushlin, Razvitie proizvodstvennogo apparata i investitsionnye protsessy", *Ekonomika i organizatsiia promyshlennogo proizvodstva*, Nov. 1984, p. 70.

[7] Joint Economic Committee, *Soviet Economy in the 1980s: Problems and Prospects*, 1982. Part I, p. 7.

though part of the explanation may lie in sub-normal agricultural performance. The share of investment has been creeping upward (table 4). Meanwhile, the share allocated to defense has remained in the 11.5 to 13.0 percent range with little variation since 1970.[8] For decisions related to intensive development, one must look at what has been happening in the supply side of the economy, i.e., policies affecting labor, land, and fixed capital and productivity. The leadership's options regarding manpower and education policies have been few, so the focus of intensive development is upon fixed capital and technology.

TABLE 4.—PROPORTIONS OF SOVIET GROSS NATIONAL PRODUCT BY END USES

[Billion 1970 rubles at factor cost]

Use	1960	1965	1970	1975	1980	1982	1983
Consumption	57.6	54.0	54.2	53.8	54.1	53.3	52.8
Investment	24.2	27.3	28.2	30.6	32.8	33.5	34.0
Other	18.1	18.7	17.6	15.6	13.1	13.2	13.2
GNP	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Sources: 1960–1970—Joint Economic Committee, "USSR, Measures of Economic Growth and Development, 1950–1980," Table A–6. 1970–1982—Joint Economic Committee, "Hearings on the Allocation of Resources in the Soviet Union and China—1983," 20 Sep. 1983. 1983—GNP estimate from Central Intelligence Agency. Investment from official estimate of growth of retail average annual growth in consumer services for 1980–1982, as estimated in second source. The "Other" calculation is a statistical residual.

Except for the lack of employment opportunities for women in one-industry, largely mining, communities, a further rise in the labor participation ratio is not feasible. The regime continues to pursue pronatalist policies, but these are neutralized by continuing housing shortages and high labor participation by women of childbearing age. The most recent labor initiative has centered on motivating workers by means of tighter labor discipline. However, tougher disciplinary measures in the work place are not a long-term solution because worker attitudes and performance are strongly conditioned by recurrent industrial supply disruptions, tight labor markets, and the necessity to use working time to purchase consumer goods.

In education, with the attainment of universal secondary education and the limit placed on greater access to academic higher education, the leadership is trying to direct more students at both the second and higher levels into vocational and technical education. Educational reforms proposed in 1984 would raise the proportion of 8th grade students assigned to vocational and professional-technical schools from 40 to 60 percent, reducing the share striving for admission to higher education.

Investment policy is focused upon measures to raise capital productivity. As noted in Table 4, the priority given investment continues to be high, as shown by its rising proportion of national product. The continuing decline in the return on investment highlights the crucial necessity to raise its productivity. But the productivity of investment depends on technological advances assimilated with the investment, so investment and technology policies are complementary.

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[8] Joint Economic Committee, *Hearings on the Allocation of Resources in the Soviet Union and China—1983,* 20 Sep. 1983, p. 10.

ACCELERATING RETIREMENTS OF FIXED CAPITAL

Attitudes and policies toward the retirement of fixed assets have contributed greatly to disappointing capital productivity performance. On average, fixed assets have been retained in service twice as long as in the major market economies.[9] Since productivity gains depend upon adding new capital incorporating recent technology and discarding technologically obsolescent old assets, Soviet practices clearly retard productivity improvement.

Asset lives are prolonged at high cost through capital repairs. In the mid-1970's, outlays for repairs were a quarter as large as gross investment in industry and nearly 40 percent as large as outlays for industrial equipment. The resource drain of repairs was considerable, absorbing a tenth of the industrial labor force and a third of the stock of machine tools.[10] Over the total lives of these assets, capital repairs generally exceeded original investment costs.[11]

Despite official recognition that shorter asset lives were desirable, the steps taken in this direction have been inadequate. The most recent change in official amortization norms in 1975 lowered average service lives for industrial equipment from 17 to 14 years,[12] compared with average lives of 10 years in France, Germany, and Italy, and 12 years in the United States.[13] A Soviet economist estimates that machinery becomes obsolescent after 8 years of service.[14]

In actual practice the official guidelines have not been followed. The annual estimates of equipment retirements in the Soviet statistical handbook are limited to those discarded because of physical wear and tear, averaging only around 2.5 percent (equivalent to a 40-year service life) in the 1970's. A Soviet economist, using a 35-percent sample, was able to include retirements for obsolescence. His estimates doubled the retirement rate and implied an average equipment service life of 20 years.[15]

REPLACEMENT RATHER THAN EXPANSION

The main new focus of Soviet investment policy—raising the share of industrial investment devoted to replacement of old assets—complements the campaign to shorten asset service lives. Traditionally, investment plans have stressed building new plant or expanding capacity of existing enterprise. By emphasizing reequipment of existing plant, Soviet planners hope to accelerate the introduction of new technology to the production line by shortening the investment cycle. Construction of new facilities is the most time-consuming element of capital investment, so the idea is to avoid construction by replacing equipment in existing buildings.

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[9] See footnote reference 3, p. 173.

[10] A. Shneiderov, "Vosproizvodstvennye proportsii kapital'nykh vlozhenii", *Voprosy ekonomiki*, Aug. 1975, p. 34.

[11] Iu. Kurenko, D. Palterovich, *Technicheskii progress i optimal'noe obnovienie proizvodstvennogo apparata*, 1975, p. 193.

[12] *Ibid.*, p. 51.

[13] V. Budavei, *Problemy amortizatsii v promyshlennosti*, p. 183.

[14] D. Baranov, *Sroki amortizatsii i obnovleniia osnovnykh proizvodstvennykh fondov*, 1977, p. 216.

[15] Ia. Kvasha, "Tekhnicheskii progress, sroki sluzhby sredstv truda i otraslevaia stuktura", in *Proportsii vosproizvodstva v period razvitogo sotsialisma*, 1976, p. 131.

Re-equipment may require some reconstruction, too, but the cost is small compared with that of a new plant.

The Soviet replacement effort has been much lower than that in the United States. In the mid-1970's, 56 percent of U.S. industrial investment was directed toward replacement and modernization.[16] In the Soviet Union the proportion was only 29 percent in the late 1970's.[17] While the U.S. proportion may be too high a standard for the Soviet Union given slower U.S. industrial growth, some Soviet economists had recommended that the Soviet share should be doubled or tripled.[18]

The replacement share has in fact been steadily rising during the 1981–85 Five Year Plan, reaching 35 percent in 1984.[19] The draft version of the projected Twelfth Five Year Plan (1986–90) set the proportion at a third, but in his rejection of this Plan version, Gorbachev reportedly insisted that it be increased to a half,[20] a revision adopted in the final version of the Plan.

The advantages of an intensified replacement effort are several fold, according to special surveys carried out in the USSR. Labor productivity is said to be about 50 percent and capital productivity 86 percent higher than in new plant construction.[21] These results reportedly were attained with cost savings of one half to two-thirds and with capacity being brought on stream 3–3.5 times as rapidly.[22]

The rising share of replacement in investment has been matched by a rising technological intensity of investment. The key feature of this trend is the accelerated automation of production. In Soviet official parlance this policy panacea is termed the "scientific-technological revolution". Automation serves the dual objectives of facilitating substitution of capital for labor in an era of worsening labor shortages and raising the productivity of capital. The growing share of high technology in production of producer durables can be seen by comparing the composition of total deliveries of producer durables since the mid-sixties and those projected for the current Five Year Plan (table 5). The producer durables deliveries consisting of high technology products may be found in the third and fourth rows of Table 5. Newer machine tools included in the third row are increasingly computer-controlled. The share of high technology products has nearly doubled since the mid-1960's and now comprises a quarter of total investment.

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[16] McGraw-Hill Publications Company, *Annual McGraw-Hill Survey of Business' Plans for New Plants and Equipment.*

[17] N. Ryzhkov, "Nekotorye voprosy planovogo rukovodstva ekonomikoi", *Planovoe khozyaystvo,* Aug. 1982, p. 5.

[18] Iu. Ivanov, *Sootnosheniia ekstensivnogo i intensivnogo protsessoi vashirenonom vosproiszvodstva,* 1980, p. 104.

[19] *Narodnoe Khozyaystvo SSSR.* 1984 p. 30.

[20] *Wall Street Journal,* June 12, 1985.

[21] V. Krasovskiy, "Investsionaia politika i rekonstrucktsiia, *Ekonomika i organizatsiia promyshlennogo proizvodstva,* Apr. 1979, p. 80.

[22] A. Briiakhin, "Khoziaistvennyi mekhanism v stroitel'stve", *Ekonomicheski nauki,* Apr. 1980, p. 80.

TABLE 5.—USSR: DELIVERIES OF PRODUCER DURABLES, BY PLAN PERIODS [1]

Group	1966–70	1971–75	1976–80	1981–85
Railway equipment, automotive equipment, agricultural machinery, construction machinery	60	58	55	49
Mining, metallurgical, hoisting equipment	12	12	19	20
Stamping-pressing, metalcutting equipment	9	10	10	13
Instruments, automation, and automic energy equipment	5	7	10	13
Total deliveries	100.0	100.0	100.0	100.0

[1] No indication of type of prices. Investment time series are measured in 1969 estimates prices, adjusted for selected wholesale price changes of 1 January 1973.

Source: V. Fal'tsman, V. Bonsov, "Mobil'nost' mashinostroeniia," Planovoe khozyaystov, Nov. 1982.

These trends in Soviet investment policy have led to a rising dependence upon foreign technology. Imports of high technology products surged during the early and mid-seventies, leveled off in the latter part of the decade, then showed signs of renewed resurgence in the 1980's.[23]

Why the Intensive Investment Campaign Stalled

Retirement rates still low and reproduction instead of replacement

The accelerated retirement guidelines adopted in 1975, as noted earlier, have not been implemented. Official retirements for wear and tear, as reported in the annual statistical handbook, have shown no significant change. Indeed, a Soviet investment specialist has asserted that rates of retirement of obsolescent assets have declined.[24] During the 1970's the average age (number of years in production) of current machinery output rose significantly. The share of new products fell from 4.3 to 2.5 percent while the share of machinery in production for more than 10 years climbed from 20 to 28 percent.[25]

The failure of the new retirement policy is explained to some extent by inadequate financing. The reduction in specified service lives has not been matched by adequate financial incentives to get rid of old equipment. Specific proportions of amortization allowances are earmarked for replacement and for capital repair. Even though the replacement proportions were raised in 1975, they are still insufficient to finance higher replacement rates. The Ministry of Finance has found it necessary to authorize transfers of accummulated and unused funds for capital repair to finance replacement outlays.[26] But the principal reason for keeping old equipment is that enterprise managers and ministry officials are led to do so by the existing incentive structure. In a market economy, firms discard old assets primarily because the new capital is usually more

[23] George Holliday, "Western Technology Transfer to the Soviet Union: Problems of Assimilation and Impact on Soviet Exports" contribution to Joint Economic Committee, *Soviet Economy in the 1980s: Problems and Prospects*, Part I, p. 517.

[24] D. Palterovich, "Obnovlenie oborudovanii i tekhnicheskoi perevooruzhenie proizvodstva", *Planovoe khoziaistvo*, Aug. 1980, p. 104.

[25] V. Fal'tsman, V. Bonsov, "Mobil'nost' machinostroeniia", *Planovoe khoziaistvo*, Nov. 1982, p. 86.

[26] B. Senchagov, "Razviti sotsialisticheskogo Khozstvennogo mekhanizma", *Voprosy ekonomiki*, May 1978, p. 42.

economical in the use of manpower and material inputs or because it is necessary to manufacture competitive products. As long as current production targets remain the overriding criterion for judging the success Soviet managers, they will have little incentive to discard obsolescent assets.

As noted earlier, replacement investment is the keystone of the push for intensive development. In analyzing past Soviet performance, it is worthwhile to distinguish between progress toward formal goals of proportions of total investment and the intrinsic effectiveness of a larger replacement effort in improving productivity. The USSR has raised the proportion of replacement in total investment, but has fallen woefully short in its bottom line objective of accelerating capital productivity.

Why have the productivity enhancing results of intensive investment not been achieved? The explanations lie first in the technical structure of Soviet investment, especially in construction technique, and second in the failure of the system to generate and assimilate the advanced technology necessary to support the replacement investment program.

CONSTRUCTION PRACTICES HINDER REPLACEMENT

The advantage of the new approach, in theory, is the time and cost savings attained by retooling without reconstruction. Existing buildings and structures supposedly can be used with little or no alteration while obsolescent machinery and equipment are replaced with technologically advanced models. The installation of automated production lines and assembly type operations in the process of retooling, however, often requires some alterations of factory buildings. Improvement in light and ventilation are often required. Reequipment is easier if the working spaces are unobstructed by immovable columns and supports. If the buildings are built of light materials (aluminum, sheet steel or asbestos-cement), structural alterations are not difficult.

However, traditional Soviet construction practices have favored heavy prefabricated concrete structures.[27] While more durable than those built of lighter materials, these buildings are less amenable to the alterations that accompany equipment replacement. In the same vein, Soviet construction design favors the use of overhead bridge cranes, rather than more mobile lifting and transport equipment. Bridge cranes require heavy columns and overhead building supports that limit the possibility of rearranging the use of floor space.

These features of Soviet industrial construction have required costly and time-consuming reconstruction as part of equipment replacement programs. In effect, the durability of Soviet construction has been self-defeating and has required that retooling be matched by reconstruction. The theoretical cost and time savings envisaged in the Soviet investment literature have not been realized.

The replacement effort has also been confronted by organizational deficiencies in construction. Construction organizations work

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[27] B. Rumer, *Investment and Reindustrialization in the Soviet Economy*, Westview Press, 1984, pp. 120–126.

best in building new plants, where standardized techniques can be used on a large scale. Reconstruction is typically carried out on a smaller scale, requiring specialized techniques for which construction organizations are ill-prepared. The incentive system is skewed toward those indicators of construction activity that characterize new construction.[28] As a result, reconstruction activity is often performed by inefficient repair organizations belonging to the enterprises being reequipped rather than by specialized construction organizations.

INVESTMENT IN OBSOLESCENT TECHNOLOGY

Since the ultimate success of the replacement investment campaign rests upon the accelerated introduction of advanced technology into the production process, technological performance is crucial. A perceptive Soviet economist analyzed the reasons for the continuing decline in the rate of return on investment. He cited such external influences as the worsening quality of natural resources, the growing share of investment in high-cost eastern and northern regions, rising pollution control outlays, and reduced manpower availabilities. However, he asserted that the principal reason has been the insufficient support of the investment process by scientific and technical progress.[29]

The explanations for lagging Soviet technological progress, with its unfavorable consequences for the policy of intensive development, lie mainly in managerial incentives, the institutional relationships between research and development and production, and the technological drain imposed the priority given to defense production.

Technological progress in market economies depends upon both consumer and supplier initiatives. In the Soviet system, the influence of the consumer is weak, except in defense production where the initiative comes from the Ministry of Defense with reinforcement from the top leadership. Innovation is inhibited by the chronic seller's market that prevails for Soviet producer durables—a trait that a Soviet scholar called "planned scarcity".[30] Under such circumstances, consumer demand provides little effective pressure for technologically-improved or lower cost products. The potent influence of consumer sanctions is absent. From the point of view of suppliers, the willingness of Soviet managers to pursue costs savings through asset replacement is deterred by what a leading Soviet investment expert terms "self reproduction", the propensity toward the perpetuation of existing technology, which has assured sources of material supply and provides near-certain production bonuses.[31]

To the absence of consumer pressures and the propensity of managers to play it safe should be added another security mechanism in managerial behavior. Reliance on longstanding sources of materials supply to insure against external (to the enterprise or minis-

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[28] *Ibid*, p. 38.
[29] See footnote reference source 6, p. 71.
[30] S. Kheinman, "Organizational and Structural Factors in Economic Growth", JPRS 76388, *USSR Report, Economic Affairs*, No. 937, Sep. 9, 1980, p. 65.
[31] *Ibid*, p. 65.

try) supply disruptions also slows technical advance.[32] Centralized planning promises a producer an adequate allocation of necessary inputs but provides no guarantee of timely and sufficient delivery.

As a result, a good deal of Soviet machinery is produced in small machine shops attached to the consuming organization rather than in large-scale machinebuilding ministries. Only the specialized ministries, however, can afford to support the research and testing facilities required to develop advanced technology. To the degree that the propensity toward vertical integration (self-sufficiency) prevails, Soviet industry forgoes the benefits of division of labor that characterize modern industry in market economies.

Even within the 20-odd machine-building ministries, product specialization does not match administrative specialization. The prevailing output profile is one of generalized production by most ministries. The prevailing exceptions are those machinery ministries largely engaged in military production. Even in the production of general purpose semi-fabricates—such as gears, castings, forgings, and stampings—the degree of specialization is far lower than in US industry. Production of single-unit customized equipment is not organized in specialized machinery ministries. By default, such items are produced in the technologically backward internal machine shops.

Technological backwardness is also explained by insufficient supplier initiative. In market economies, most technical progress at the plant level originates in sales pressure by equipment suppliers. The basic Soviet shortcoming is institutional. In the Soviet system, research and development is separated originally from production. The incentives for R&D organizations reward expenditures of budget allocations more than completion of projects or the satisfaction of consumer demand.[33] This supplier-consumer gap is not closed by the central planning coordination process.

The defects in Soviet technological performance are thus mainly systemic in nature. Their amelioration will require major reforms in central planning institutions. The other major deterrent to technological progress in the production of producer durables is the superior priority accorded to defense production. As noted earlier (table 4), this priority has not been reflected in Soviet macro-economic policy. While the share of GNP allocated to defense has changed little over the past decade, that for investment has risen steadily. It is rather through the preemption of advanced technological resources and the economy's innovational energies that the burden of defense falls upon investment productivity.

The cutting edge of improved capital productivity is the application of high technology in the production of producer durables. Within the Soviet industrial classification (as quantified in official Soviet interindustry studies), high technology would include the following sectors: precision instruments, communications and other electronic equipment, transportation machinery and equipment, and electrotechnical machinery and equipment.[34] The changing

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[32] Iu. Subotskii, "Role of Production Specialization in Reducing Scattering", JPRS 80078, *USSR Report, Economic Affairs*, No. 998, Feb. 14, 1982, p. 34.

[33] See footnote reference 5, p. 14.

[34] In the reconstructed Soviet input-output tables for 1966 and 1972 (see footnote reference 35) these would be rows 19, 33, 29, and 13, respectively.

composition of investment durables purchases, which reflects the rising high technology ingredients has been shown in table 5.

The heavy defense production drain on high technology output may be deduced by combining information in the reconstructed versions of Soviet interindustry tables [35] with estimates of the breakdown of deliveries of machinery to investment by a Soviet economist.[36] In 1966, the military probably account for more than half of final demand for the four high technology machinery sectors.[37] In 1972, defense claims pre-empted a similar proportion of high technology output. Conclusions for 1977 are more tentative, but they indicate that the military procurement claim was of approximately similar magnitude.

The technological burden of military production appears even larger when product quality considerations are introduced. Information obtained from interviews with emigres reinforces the presumption that the presence of military inspectors in all plants producing defense products enables the Ministry of Defense to refuse defective or inferior output, a privilege not accorded to civilian customers. The observers also assert that factories that produce products with both military and non-military applications set higher quality standards for their military customers.

The importance of advanced technology to the accomplishment of increasing capital productivity cannot be underestimated. As noted in table 5, during the current five year plan, a quarter of all investment durables consists of high technology products. Some notion of future trends in the high technology content of Soviet investment may be conveyed by recounting recent US experience. By the early 1980's, purchases of office and computing machinery and communications equipment comprised over a third of producer durables component of new fixed investment.[38] If this definition of high technology investment is expanded to include scientific and engineering instruments and photographic equipment, then the share rises to nearly half.[39]

The rising investment imperative collides directly with the continuing upgrading of the technological content of military production. Even though there has been little increase in total military procurement levels in the Soviet Union since the mid-seventies,[40] production of most types of missiles has been increasing.[41] For such weapons systems as aircraft and submarines, which have had unchanging production levels, there have been continual advancements in technological sophistication.[42]

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[35] Barry Kostinsky, *The Reconstructed 1966 Soviet Input-Output Table: Revised Purchasers' and Producers' Price Tables* (Foreign Economic Report No. 13), 1976. U.S. Department of Commerce, Foreign Documents Division, *Input-Output Structure of the Soviet Economy—1972*, (foreign Economic Report No. 18).

[36] V. Fal'tsman, *Potentsial investitsionogo mashinostroenie*, Nauka, 1981.

[37] Stanley Cohn, *Soviet Investment Productivity Imperative and the Economic burden of Defense*, Report prepared for the National Council for Soviet and East European Research, June 1983.

[38] *Survey of Current Business*, July 1983, p. 65.

[39] *Survey of Current Business*, Oct. 1983, p. 5.

[40] Joint Economic Committee, *Hearings on the Allocation of Resources in the Soviet Union and China—1983, Sep. 1983, p. 10.*

[41] Joint Economic Committee, *Soviet Defense Trends*, (Staff study), Sep. 1983, p. 8.

[42] Richard Kaufman, "Causes of the Slowdown in Soviet Defense", *Soviet Economy*, January-March 1985.

Prospects for Successful Intensive Development

As the June CPSU Plenum affirmed, the future dynamism of the Soviet economy depends upon successful implementation of an intensive growth strategy. To date the fruits of the "new" approach have been meager. The common theme that emerges in the analysis of the failure is the unsuitability of centralized planning and control as an institutional framework for implementing intensive development. While admirably devised for directing the resource mobilization that promoted extensive development, it is ill-suited to stimulate the productivity improvements which are the core of the intensive approach.

Economists have differentiated between tangible and intangible technical progress. The tangible component refers to improvements in the quality of inputs, whether human or material. Such qualitative improvements flow from education and technical progress (R&D), respectively. The intangible component depends upon the ingenuity of management in organizing factor inputs in the production process. All of these improvements depend upon individual efforts and cannot be prescribed by centralized fiat.

This conclusion has been most recently reflected in a limited dissemination statement prepared by a group of Soviet economists affiliated with the Academy of Sciences' Siberian Division in Novosibirsk. Citing the steady decline in economic growth in recent years, the Novosibirsk economists blamed the traditional system of administrative methods, with its high degree of centralized decision making. They urged its replacement by "truly economic" (socialist market) methods of management.[43]

The group highlighted the continuing improvement in the quality of worker and managerial skills and criticized the failure of the system to adjust to "the core of highly skilled workers" who are better educated than their predecessors and capable of "critically assessing the activities of political and economic leaders". The essence of the new institutional arrangements would be the vast expansion in the authority of the "leading officials of enterprises". In particular, plant managers should be freed from centrally imposing constraints in such matters as investment, technological innovation, and wage and salary payments. The reforms introduced by Andropov and Chernenko only tinkered with existing institutions.

Pronouncements and actions of Gorbachev have been equally cautious. In his keynote speech to the 27th Party Congress he clearly recognized the critical need for the system to stress modernization of obsolescent production processes, more effective management at the enterprise and production association levels and improved labor controls and incentives. However, his prescriptions were too traditional to dramatically raise productivity performance.[44]

In particular, he focused institutional improvements at the Gosplan level. Only limited new decision-making power is to be granted to enterprise management, broadening the previously introduced "Five-Ministry Experiment" which gave enterprises greater

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[43] *The New York Times*, Aug. 5, 1983.
[44] *Pravda*, February 26, 1986.

control over investment and wage funds. The establishment of superbureaus to oversee the machine building and energy production sectors is a further enlargement of centralized control.

He did propose positive steps toward improvement capital productivity by a doubling of asset retirement rates, but at the cost of heavier investment commitments to the machinery production sector. His insistence upon rapid increases in current rates of industrial output strengthens the ongoing managerial incentive bias toward current output and against new product innovation. His address made no mention of the institutional gap between research and development and production, which has hampered new product innovation. Thus, little progress is being made toward rectifying the causes of low productivity advancement. To these institutional short-comings must be added the apparent determination to maintain the dominating resource priority of defense production.

It would be unrealistic to expect reforms as drastic as those suggested by the Novosibrisk academicians. However, both internal and external precedents exist for more limited reforms. The gulf between R&D and innovation has been bridged by the organizational arrangements within Soviet defense production. Civilian industrial ministries could also be given control over relevant R&D organizations.

East Germany, while retaining central planning, has accorded limited decentralization to intermediate industrial echelons. These organizations have limited authority in such key decisions as composition of output, supplier contracts, and technology choice.[45] The GDR at the same time has managed to attain respectable growth rates in the face of erosion in its demographic base. While its superior productivity performance, compared with other socialist countries, cannot be wholly ascribed to its limited decentralization, the influence of these reforms must be accorded serious attention. Another important organizational departure by East Germany from the Stalinist norm has been its system of managerial incentives. Unlike his Soviet counterpart, performance of an East German manager is based on his performance over several years, not just the current year.[46] Thereby, his success in achieving productivity gains weights heavily in his evaluation. This would be an easy precedent for Soviet emulation.

More sweeping precedents are found in the Hungarian and Chinese responses to economic stagnation. In both cases, the devolution of decision making authority has been more thorough. (The long established Yugoslav market socialist model is of limited appeal to Soviet planners because of its unique feature—worker's management.) In its 17-year life, the Hungarian experiment has labored under contraints of unfavorable external economic developments and internal limitations on the full implementation of reforms. But it has survived and transformed the Hungarian economy into a viable international competitor and into a consumer society. The Chinese reforms have achieved impressive accomplish-

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[45] Doris Cornelsen, "The GDR in a Period of Foreign Trade Difficulties" contribution to Joint Economic Committee, *East European Economic Assessment*, Part I, 1981, pp. 316-320.

[46] David Granick, *Enterprise Guidance in Eastern Europe: A Comparison of Four Socialist Economies*, Princeton University Press, 1975, p. 4.

ments in agriculture and, more recently, in industrial production. While they may be economically attractive to Soviet Party leaders and planners, they also require disruptive and wrenching changes in power relationships. Whether Soviet leaders will be willing to try significant institutional reforms is still to be demonstrated.

ON THE FEASIBILITY OF KEY TARGETS IN THE SOVIET TWELFTH FIVE YEAR PLAN (1986–90)

By Ed A. Hewett,* Bryan Roberts,** and Jan Vanous**

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SUMMARY

In this paper we explore the feasibility of key targets for the Twelfth Five Year Plan (FYPXII, 1986–90). Where possible we rely on official plan targets to represent Soviet intentions. However, that still leaves gaps on many important variables, and here we must speculate on what the actual or implied targets may be. In order to explore the likely consistency of plan targets we rely in part on simple consistency tests, and in part on a model developed at PlanEcon, SOVECON, which is designed to study the medium-term implications of shifts in investment policies, given assumptions on factor productivities and other key variables. Our focus here is primarily on the macroeconomic targets, or those for major sectors. We will not discuss in detail specific sectoral issues, nor will we go into the very important qualitative side of FYPXII, except where it has direct bearing on the issues raised here. We simply wish to limit ourselves to one of the several important considerations which go into reaching a judgement on the feasibility of FYPXII, namely the question of internal consistency at the macro level.

We begin the paper in Section II with a summary of the targets for FYPXII and an analysis of performance through 1986. Section

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III focuses on investment policy, which lies at the heart of FYPXII. Our conclusion here is that the official investment growth targets are implausibly low, and some of the targets for individual investment categories or sectors are too ambitious. We develop what we regard as a more likely scenario and explore the implications for the structure of investment for the remaining years of the five-year plan. Section IV explores, with the aid of SOVECON, the implications of that investment scenario for the performance of the economy through 1990. We conclude in Section V with a few thoughts on interesting issues for future research.

I. Key Plan Targets for 1986–1990

The targets for FYPXII were the subject of considerable struggle between Mikhail Gorbachev and the economic bureaucracy beginning in 1984 when Gorbachev was still "second" secretary. (Hewett, 1985, 286–87) Gorbachev was pressing for more ambitious targets than Gosplan was willing to accept, the result being multiple drafts of FYPXII, and eventually the removal of Nikolai Baibakov. The draft which finally emerged was indeed quite ambitious, as can be seen in the summary figures in table 1.

TABLE 1.—SOVIET ECONOMIC PERFORMANCE, PLANNED AND ACTUAL, 1981–90

	1981–85		1986–90 draft plan	1986	1987	1988	1989	1990	1986 plan	1986 actual	1987 plan
	Five-year plan	Actual									
	(1)	(1a)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
National income produced		3.5	[a] 4.5						(10) 3.9	4.1	[e] 4.1
National income utilized	3.4	3.1	[b] 4.1	3.8	4.0	4.1	4.2	4.3	3.8		
Total labor productivity		3.1	4.2						3.8	3.8	[e] 4.0
Labor productivity in industry	3.6	3.2	[c] 4.6	4.1	4.4	4.5	4.7	5.1	4.1	4.8	[e] 4.4
Labor productivity in construction		2.7	[c] 3.9	3.5	3.7	4.0	4.1	4.1	3.5		[e] 3.8
Industrial production	4.7	3.7	[b] 4.6	4.3	4.4	4.5	4.7	4.9	4.3	4.9	[e] 4.4
Agricultrual production	4.7	2.1	[b] 2.7						4.4	5.1	7.6
MBMW production	7.0	(1b) 6.2	[c] 7.4						6.6		[e, f] 7.3
Industrial group A production (investment goods)		3.7	[b] 4.4	4.3	4.3	4.4	4.5	4.7	4.1	5.2	[e] 4.3
Industrial group B production (consumer goods)		3.9	[b] 4.9	4.4	4.5	4.7	5.3	5.5	4.9	4.0	[e] 4.5
Capital put into operation		(1c) 3.0							14.1	6.0	
Total investment		3.5	4.3						7.6	8.0	[e] 4.6
State investment	1.1	(1d) 3.5	[c] 2.9	9.9	−1.0	1.8	1.7	2.0	8.2		[e] 5.1
MBMW sector investment		(1e) 4.0	[b] 12.5						30.0		
Retail trade turnover		3.0	[c] 5.9	3.9	6.0	5.9	6.0	6.0	[d] 3.6	6.4	[e] 5.9
Real per capita income		2.1	[b] 2.7	2.5	2.4	2.9	2.8	2.7	2.5	2.3	[e] 2.6

[a] Implied average annual growth rate derived from data on labor productivity and labor force growth.
[b] Average annual growth rate derived from 5-year plan growth rate: ((1986–90) value)((1981–85) value).
[c] Average annual growth rate derived from (1990 value/1985 value).
[d] 1986 plan figure includes alcoholic beverages; all other retail trade turnover figures do not.
[e] Percent of 1986 plan.
[f] MVMW Ministries output (uncertain if equivalent to MBWM branch output).

Sources :

(1) Ed A. Hewett, "Gorbachev's Economic Strategy : A Preliminary Assessment," Soviet Economy 1:4 (Oct.–Dec. 1985), p. 284.
(1a) Soviet official data from Narodnye Khoziaistvo 1985, p. 40.
(1b) Narodnoe Khoziaistvo 1985, p. 363.
(1c) Narodnoe Khoziaistvo 1985, p. 368.
(1d) Narodnoe Khoziaistvo 1985, p. 358.
(1e) Narodnoe Khoziaistvo 1985, p. 128.
(2) Nikolai Ryzhkov, "O gosudarstvennom plane ekonomicheskogo i sotsial'nogo razvitiia SSSR na 1986–1990 gody (On the State Plan for the Economic and Social Development of the U.S.S.R. in 1986–1990)", Pravda June 19, 1986, 1–3.
(3)–(7) "Zakon Soiuza Sovetskikh Sotsialisticheskikh Respublik. O gosudarstvennom plane ekonomicheskogo i sotsial 'nogo razvitiia SSSR na 1986–1990 gody" (Law of the Union of Soviet Socialist Republics. On the State Plan of Economic and Social Development of the U.S.S.R. during 1986–1990), Ekonomicheskaia gazeta, 26:14–15, June 1986.
(8) Nikolai Talyzin, "O gosudarstvennom plane ekonomicheskogo i sotsial'nogo razvitiia SSSR na 1986 god i vypolenii plana v 1985 godu (On the State Plan for the Economic and Social Development of the U.S.S.R. in 1986 and Plan Fufillment in 1985)," Ekonomicheskaia Gazeta #46 1985.
(9) U.S.S.R., Central Statistical Office, "Piatiletke—kachestvo i tempy (Five-Year Plan—Quality and Growth)," Pravda, January 18, 1987.
(10) Nikolai Talyzin, "O gosudarstvennom plane ekonomicheskogo i sotsial'nogo razvitiia SSSR na 1987 god i vypolnenii plana v 1986 godu (On the State Plan for the Economic and Social Development of the U.S.S.R. in 1987 and Plan Fufillment in 1986)," Ekonomicheskaia Gazeta #48 1986.

The first two columns of Table 1 present planned and actual figures for FYPXI (1981-85) for purposes of comparison. The next column gives the annual average growth rates planned for key indicators according to FYPXII. It is followed by five columns specifying the annual path for key indicators, based on the plan law. The last three columns report on the annual plan for 1986, actual performance that year, and the annual plan for 1987. The best summary indicator of the tautness of this plan is the target for National Income Produced, which is set at 4.5 percent, a full point above the actual during 1981-85. The growth rate of labor productivity in the material sectors is targeted for 4.6 percent, 1.1 percent higher than actual during 1981-85, indicating the necessity of basing the growth acceleration almost solely on growing factor productivity. Labor force and capital stock growth rates are falling, and will continue to fall. Therefore it is only through reversing what has been a decline in their productivities that the growth acceleration can be accomplished.

The annual versions of the five-year plan (columns 3-7) show the acceleration gaining momentum during the remainder of the decade. The underlying assumption seems to be that the acceleration, if it is to occur, will take time. We presume, although there are no official figures, that the full version FYPXII calls for the growth rate of NI Produced to rise from the 4.1 percent planned for 1986 to 5 percent by 1990, where it is to stay for the remainder of that decade. The Soviet economy has not achieved 5 percent growth rates for NI Produced since the early 1970s, when labor force growth rates were averaging 1.8 percent and capital stock was growing at 8.7 per annum. Now, with labor force growth rates at 0.5 percent, and capital stock growing at approximately 6 percent per annum, moving up to 5 percent per anum for NI Produced will be a considerable feat. (Hewett, 1985, 290) Of particular interest in light of these ambitious output targets is the plan to hold the growth of total investment down to an average of 4.3 percent per annum, and state investment to an even lower 2.9 percent, the difference presumably reflecting an acceleration in investment by cooperatives and private individuals. The target for total investment is higher than the actual 3.5 percent of 1981-85 (which in turn was presumably much higher than the target for those years, although we only know the relationship for state investment). Nevertheless, it is surprisingly low given the intent to accelerate the rate of real depreciation (for example doubling scrapping rates in industry), and at the same time to accelerate the growth rate of output. This is just one of several indicators that Soviet planners shall either have to abandon the investment targets, or the output targets. We postpone to Section III a more detailed discussion of the inconsistencies between the investment targets and other targets.

We are already in the midst of the second year of FYPXII, and therefore are beginning to develop some notion of how the economy is responding to the effort to accelerate growth. The actual figures for 1986, and plans for both 1986 and 1987 are given in Table 1. We rely here solely on official figures although we are concerned that these figures may overstate performance in 1986 because of what was, in effect—whether intentional or not—an attempt to hide the inability of the system to supply consumers with satisfactory sub-

stitutes for reduced alchohol supplies.[1] To the extent that is the case, and we shall know more in a year when the 1986 *Narkhoz* is published, it simply makes for an even more ambitious set of targets for FYPXII.

The targets for the 1986 plan were announced in November 1985, seven months before the approval of the FYPXII targets, and were presumably part of the same calculation. As a result the figures for the 1986 are close to the five-year targets for FYPXII, and almost identical to the 1986 targets in the FYPXII law. (Col. 3 of Table 1) Although we have grave doubts about the accuracy of the NI Produced figure, we note for the record that NI Produced is reported at 4.1 percent in 1986, slightly above target. But industrial production and labor productivity in industry, both indicators in which we place somewhat more confidence, show growth well above plan. Real per capita income was slightly below the 1986 target, which is probably in part explained by the underfulfillment of plans for increasing output of Group B industrial goods. In short, the 1986 plan, which was an ambitious one, appears to have been fulfilled for many, although not all, important indicators. Consumers seem to have taken the brunt of any shortfalls, although that must remain a tentative conclusion until more data on 1986 become available. But it is surely the case that an important contributing factor to the satisfactory performance in 1986 was the high investment growth rates of approximately 8 percent, double that planned for the 1986–90 period. Actual investment was a little bit higher than planned, 8 percent vs. 7.6 percent planned for total investment, which in turn showed up in an acceleration in new capital put into operation from an average of 3 percent in 1981–85 to 6 percent in 1986.

That was well below the very ambitious 14 percent Soviet planners had hoped for, but still respectable by recent standards. The breakdown of FYPXII targets into annual targets is only available for state, but not total, investment. It shows a burst in investment in 1986 followed by a slight decline in 1987, then very slow growth for the remainder of the decade, hovering slightly under 2 percent per annum. Presumably the annual time path for planned total investment is similar. On the other hand, the 1987 annual plan targets call for a growth rate in total investment of 4.5 percent, down from 7.6 percent in 1986, but still well above the zero figure one would expect, based on FYPXII targets. In fact what seems to be emerging is a familiar pattern in Soviet planning practice in which the five-year targets for investment are so optimistic (in the sense that levels of capital productivities are expected to be so high that low investment is required to achieve desired output levels) that they are cast aside immediately in favor of more realistic annual plan targets, the result being that the first few years of annual targets provide a much more useful reading on investment policy than the five-year target. During FYPX (1976–80), for example, when the five-year target for state and cooperative capital expenditures was

[1] For a discussion of these issues, see "The Dark Side of Glasnost': Unbelievable National Income Statistics in the Gorbachev Era", *PlanEcon Report*, III, 6, February 13, 1987; and the report of the 1987 Panel on Soviet Economic Activity, in *Soviet Economy*, III, 1, January–March 1987.

set at 2.8 percent, the annual plan targets were consistently higher, as were actuals until the last two years of the plan when serious difficiulties emerged in the entire system. During FYPXI (1981–85) the target for state and cooperative investment of 1.1 percent was totally irrelevant, as shown by annual plan growth rates, which never fell below 3 percent per annum, and an actual growth of 3.8 percent per annum. (Hewett, 1987, Ch II) Now it would appear that, once again, the five-year plan targets are proving unrealistic and the annual plan targets are providing a better reading on the emerging investment policy.

The actual performance in 1986, and the plans for 1986 and 1987, jointly suggest an investment policy in which state investment will grow more rapidly than the total (a natural consequence of the modernization program), and both will grow at rates well above 4.3 percent target. We leave to the next section the discussion of what a more realistic figure might be. Before taking up the issue of investment, it is interesting to note one apparent change in Soviet planning practice which, if it persists, will prove to be important. Under Gorbachev's reforms we are again hearing the oft-repeated promise that plans will be stable for the five-year period, whether they are over- or under-fulfilled. In the past this has proven an empty promise, both at the enterprise and the national level, as annual plans have adjusted to follow performance up or down with total disregard for the five-year targets. Yet, in this five-year plan things have begun differently. Notice, for example, that although the targets for industrial output, industrial productivity, and industrial group A production were all overfulfilled, that nevertheless the 1987 target is set at the level specified in FYPXII, well below actuals in 1986. A similar pattern has emerged in some of the energy targets where, for example, coal production exceeded the 1986 target, yet the 1987 target is set below 1986, and on the time path specified for 1986–90 (coal production was 751 million tons in 1986 and exceeded the 1986 plan target by 2 percent, yet the 1987 plan gives a target for coal production of 743.6 millions tons).[2]

Other targets showed more traditional behavior (investment and agricultural production for example), but if the treatment of overfulfillment in industry becomes the norm, then this is an important departure from past planning practice, and a step in the direction of eliminating the infamous "ratchet."

II. Exploring the Feasibility of the Investment Plan

The plan for investment lies at the heart of any Soviet five-year plan. The total growth rate for investment, combined with the sectoral allocations, determine the pace and structure of capacity expansion, which—in combination with capital productivities—sets the pace of output expansion. Investment plays a particularly critical role in FYPXII in light of Gorbachev's breathtaking targets for

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[2] Actual 1986 coal production is taken from U.S.S.R, Central Statistical Office, "Piatiletke—kachestvo i tempy (Five-Year Plan—Quality and Growth), "*Pravda*, January 18, 1987. Planned 1987 target for coal production is taken from Talyzin, Nikolai, "O gosudarstvennom plane ekonomicheskogo i sotsial'nogo razvitiia SSSR na 1987 god i vypolnenii plana v 1986 godu (On the State Plan for the Economic and Social Development of the USSR in 1987 and Plan Fufillment in 1986)," *Ekonomicheskaia Gazeta* #48 1986.

the modernization of the entire system. The focus here is on the civilian machine building industries which, by the Soviets own estimates, now manage to meet "world standards" in only 29 percent of their serially-produced output. They hope that by 1990, just a few years from now, that figure can be in the range of 80 percent to 95 percent. (Ryzhkov, 1986, 2). Taken at face value this suggests that by 1990, only a few years from now, Soviet leaders hope to see the bulk of Soviet manufactured goods match Japanese, U.S. and European quality standards.

In order to accomplish or even approach those targets, it will be necessary to substantially replace existing Soviet capital stock in MBMW with new modern equipment, and to do so in the first years of the five-year plan, to allow the new serially-produced products to find their way into the system. The five-year plans confirm that the Soviets are quite serious about this target. As table 1 showed, the target for MBMW investment (civilian) calls for an average annual growth rate of 12.5 percent and the 1986 plan called for a 30 percent increase in investment in MBMW in that year alone. It is virtually certain that they did not in fact achieve that high rate of investment, but it is also certain that by past standards investment exploded in that sector in 1986.

That rapid and substantial shift of resources towards MBMW in the context of 4.3 percent growth of total investment implies that other sectors shall be giving up substantial resources. Precisely who will pay is difficult to say, since unfortunately the Soviets have not published anything even approaching a full set of investment accounts planned for 1986–90. We have assembled in table 2 our best understanding on how that investment plan might look, assuming total growth of 4.3 percent, and using the few firm plan targets for components given in the plan or the accompanying commentary.

TABLE 2.—SOVIET INVESTMENT IN FIXED CAPITAL: ACTUAL AND PLANNED

	Billion rubles, 1984 rubles											Year-to-year growth rates									
	Actual						Planned					Actual					Planned				
	1980	1981	1982	1983	1984	1985	1986[a]	1987[b]	1988[b]	1989[b]	1990[b]	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Total investment	150.9	156.5	161.9	171.0	174.3	179.5	193.9	202.8	208.9	215.1	221.6	3.71	3.45	5.62	1.93	2.98	8.00	4.60	3.00	3.00	3.00
Plant and structures	82.7	84.4	86.0	89.6	90.5	91.7	94.6	93.8	91.2	88.0	84.2	2.06	1.90	4.19	1.00	1.33	3.16	−.81	−2.81	−3.49	−4.31
Machinery and equipment	53.9	56.6	59.3	63.4	64.3	67.6	77.3	85.5	93.2	101.6	110.8	5.01	4.77	6.91	1.42	5.13	14.30	10.70	9.00	9.00	9.00
Project design	2.7	2.4	2.4	2.4	2.5	2.6	2.9	3.1	3.3	3.5	3.8	−11.11	.00	.00	4.17	4.00	11.54	8.38	6.32	6.22	6.12
Other investment expenditures	11.6	13.1	14.2	15.6	17.0	17.6	19.1	20.3	21.1	21.9	22.8	12.93	8.40	9.86	8.97	3.53	8.52	6.17	4.03	4.02	4.01
Productive	111.2	115.0	118.6	124.9	126.5	129.8	141.6	149.1	156.5	164.3	172.6	3.42	3.13	5.31	1.28	2.61	9.09	5.31	4.92	5.00	5.08
Industry, agriculture, and construction	89.1	91.8	94.3	98.4	99.0	103.1	113.0	118.8	125.0	131.6	138.8	3.03	2.72	4.35	.61	4.14	9.60	5.10	5.23	5.33	5.44
Fuels and energy complex	17.4	18.9	20.2	21.3	22.2	25.3	26.9	28.5	30.3	32.2	34.2	8.62	6.88	5.45	4.23	13.96	6.20	6.20	6.20	6.20	6.20
Metallurgy complex	5.2	5.7	6.0	6.3	6.0	5.9	6.6	7.0	7.6	8.1	8.7	9.62	5.26	5.00	−4.76	−1.67	11.86	6.80	7.21	7.20	7.18
Machinebuilding complex	13.1	13.6	13.7	14.6	14.9	15.9	20.7	22.4	24.3	26.4	28.7	3.82	.74	6.57	2.05	6.71	30.00	8.51	8.51	8.51	8.51
Chemicals and wood products complex	6.5	6.2	6.5	6.7	6.8	6.7	7.0	7.7	8.4	9.3	10.2	−4.62	4.84	3.08	1.49	−1.47	4.48	9.70	9.80	9.89	9.99
Construction complex	8.1	8.1	8.3	8.6	8.3	8.4	9.1	9.6	10.0	10.5	11.1	.00	2.47	3.61	−3.49	1.20	8.33	5.00	5.00	5.00	5.00
Light industry complex	2.0	2.1	2.1	2.3	2.3	2.2	2.3	2.5	2.7	3.0	3.2	5.00	.00	9.52	.00	−4.35	4.55	9.00	9.00	9.00	9.00
Agro-industrial complex	33.3	34.0	34.5	36.0	35.1	35.3	36.9	37.3	37.6	38.0	38.4	2.10	1.47	4.35	−2.50	.57	4.53	1.00	1.02	1.04	1.06
Other industry	3.5	3.2	3.0	2.6	3.4	3.4	3.6	3.7	3.9	4.1	4.3	−8.57	−6.25	−13.33	30.77	.00	4.75	5.00	5.00	5.00	5.00
Transport and communications	18.1	18.9	19.9	21.4	22.6	21.9	23.8	25.0	26.2	27.6	28.9	4.42	5.29	7.54	5.61	−3.10	8.68	5.00	5.00	5.00	5.00
Nonproductive	39.7	41.5	43.3	46.1	47.8	49.7	52.3	53.7	52.4	50.9	49.0	4.53	4.34	6.47	3.69	3.97	5.23	2.60	−2.33	−2.97	−3.72

[a] 1986 annual plan from Nikolai Talyzin, "O gosudarstvennon plane ekonomicheskogo i sotsial'nogo razvitiia SSSR na 1986 god i vypolnenii plana v 1985 godu (On the State Plan for the Economic and Social Development of the U.S.S.R. in 1986 and Plan Fulfillment in 1985)," Ekonomicheskaia Gazeta #48 1985.

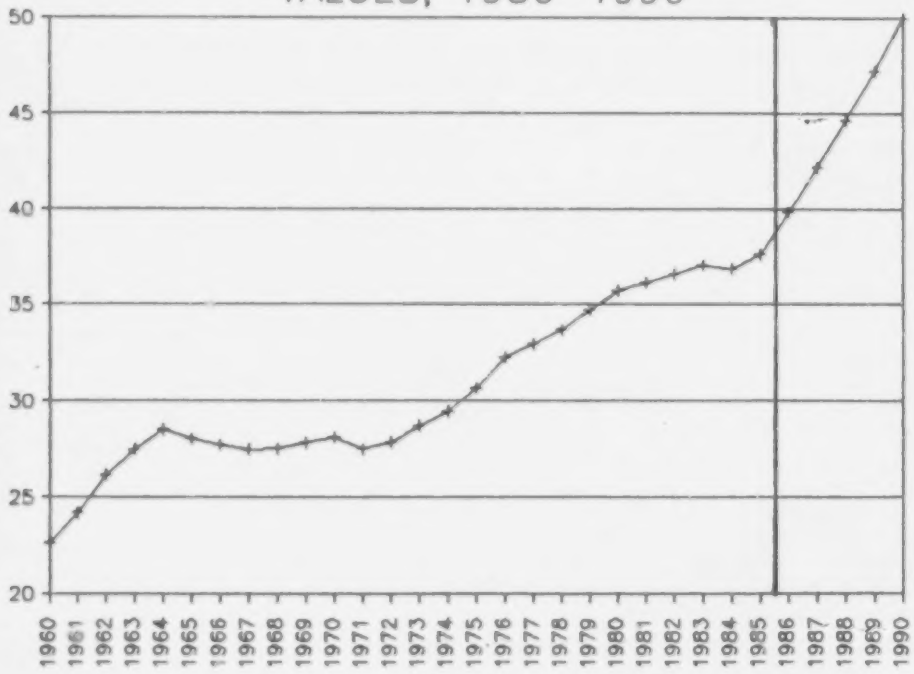
[b] Plan targets for these years can be derived for total investment, share of equipment and machinery investment in total investment and investment in the energy/fuels and MBMW complexes. Targets were given as total growth over the five-year plan. Further details on plan targets and derivation of growth rates of sectors for which no plan targets have been given are available on request.

Planned targets are available for the annual growth rate of total investment in 1986 and 1987 and the five-year growth rate over 1986–90, the share of investment in equipment and machinery (hereafter E&M) in total investment in 1990, the annual growth rate of investment in the MBMW complex in 1986 and the five-year growth rate over 1986–90, and the five-year growth rate of investment in the energy/fuels complex over 1986–90. We have used these targets and reasonable assumptions on sectors and complexes for which targets have not been given to develop a likely picture of Soviet investment plans over 1986–90.

It is clear from this balance that certain key goals of the Soviet 1986–90 investment plan should be regarded with great skepticism. Most importantly, the planned growth of the share of investment in E&M in total investment, from 38 percent in 1985 to 50 percent in 1990, is unprecedented in documented Soviet economic history, as can be seen in the trends illustrated in graph 1 below. This share growth also implies an unrealistically high growth of the level of investment in E&M, as can be seen in graph 2. Planned growth of this investment category in 1986 is higher than growth in any other year in the period 1960–85, and annual growth rates planned for 1987–90 imply a return to growth not seen since the early 1970's. The target for this investment category additionally implies negative annual growth rates for investment in plant and structures over 1987–90. While Soviet leaders clearly desire such an outcome, it seems implausible in view of traditional Soviet investment behavior and the ambitious modernization targets for FYPXII. Finally, the planned growth for investment in E&M implies an imbalance in the demand for and supply of machinery, which will be discussed further below.

GRAPH 1

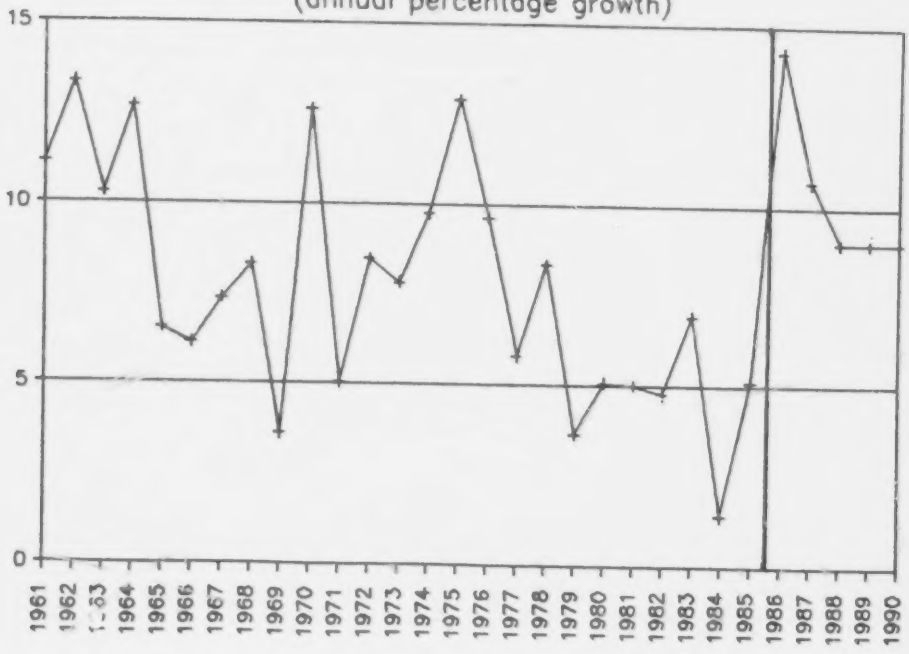
RATIO OF INVESTMENT IN EQUIPMENT AND MACHINERY TO TOTAL INVESTMENT, HISTORIC VALUES, 1960–1985 AND OFFICIALLY PLANNED VALUES, 1986–1990



GRAPH 2

GROWTH OF INVESTMENT IN EQUIPMENT AND MACHINERY, HISTORICAL VALUES, 1961–1985 AND OFFICIALLY PLANNED VALUES, 1986–1990

(annual percentage growth)



The growth of investment in productive sectors implies negative annual growth rates of investment in nonproductive sectors over 1988–90. This means either that the Soviets plan to neglect the productive sectors for which we have no plan targets or that they will indeed allow for a slowdown in the economy's capacity to satisfy needs for consumer services. The former is unlikely, as shortages of important raw materials and transport services have become critical in recent years and our projection of growth in investment in the agro-industrial complex is already very low. The latter is inconsistent with the goal in the Soviet Five-Year plan of increasing the supply of consumer services:

"Appreciable priority growth, in comparison with the increase in the production and sale of consumer goods, is envisaged for paid services. They will grow by 50 percent over the five-year period (1986–90)."

"The Party has set a task of enormous social significance—seeing to it that practically every family has a separate apartment or an individual house by the year 2000." (Ryzhkov 1986.)

The plan for growth of investment in the energy/fuels complex is very optimistic as it will probably require a good deal more growth over 1986–90 than the planned figure of 35 percent. The Soviets postulate another tremendous increase in the production of gas (850 billion cubic meters produced in 1990, up from 643 in 1985 and 435 in 1980), recoveries in the production of oil (635 million tons produced in 1990 as opposed to 595 in 1985 and 603 in 1980) and coal (795 million tons produced in 1990 as opposed to 726 in 1985 and 716 in 1980), and continued growth of electricity output (1860 billion kilowatt/hours in 1990 as opposed to 1544 in 1985 and 1294 in 1980).[3] Based on the fact that the planned growth of production in various energy/fuels complexes is equal to or greater than those achieved in the period 1981–85, and the rate of growth of investment over 1981–85 was 51.2 percent, it seems very unlikely that the Soviets can meet their energy output targets with only 35 percent growth of investment in this complex, especially when one considers that the locus of energy production continues to move to the eastern regions of the U.S.S.R., where costs are much higher than in the western U.S.S.R.

The official Soviet investment plan can be used to derive a machinery balance in which the demand for equipment and machinery produced in the Soviet economy (consisting of gross investment in E&M, intermediate machinery production, consumer durables output, capital repair of E&M, defense machinery production, and exports of investment machinery) is compared with the supply of equipment and machinery (consisting of gross machinery output and imports of investment machinery). Such a balance is shown in Table 3. Domestic investment machinery production was determined by subtracting intermediate machinery, consumer durables, and defense machinery production and capital repair from gross machinery production. Net imports of investment machinery were added to supply of domestic investment machinery to obtain total available investment machinery. This was subtracted from demand

[3] Historical (1980 and 1985) production figures are taken from *Narkhoz 1985*. Planned (1990) production figures are taken from Ryzhkov 1986.

for investment machinery (=gross investment in machinery and equipment) to give the category "inventory change/unidentified source." (The derivation of each variable of supply and demand is described in the table's footnotes).

TABLE 3.—SOVIET MACHINERY BALANCE (OFFICIAL SOVIET INVESTMENT DATA)

	Billion rubles, 1984 prices											Annual growth rate									
	Historical						Planned					Historical					Planned				
	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1981	1982	1983	1984	1985	1986	1987	1988	1989	1930
DEMAND FOR INVESTMENT MACHINERY GOODS																					
Gross total investment in fixed capital	150.9	156.5	161.9	171.0	174.3	179.5	193.9	202.8	208.9	215.1	221.6	3.71	3.45	5.62	1.93	2.98	8.00	4.60	3.00	3.00	3.00
Minus gross investment in structures	82.7	84.4	86.0	89.6	90.5	91.7	94.6	93.8	91.2	88.0	84.2	2.06	1.90	4.19	1.00	1.33	3.16	−.81	−2.81	−3.50	−4.32
Minus other investment expenditures	14.3	15.5	16.6	18.0	19.5	20.2	22.0	23.4	24.4	25.5	26.6	8.39	7.10	8.43	8.33	3.59	8.91	6.46	4.34	4.32	4.30
Equals gross investment in machinery and equipment	53.9	56.6	59.3	63.4	64.3	67.6	77.3	85.5	93.2	101.6	110.8	5.01	4.77	6.91	1.42	5.13	14.30	10.70	9.01	9.01	9.01
SUPPLY OF INVESTMENT MACHINERY GOODS																					
Gross machinery production	163.0	172.5	180.8	192.3	205.7	220.4	234.9	252.1	271.5	292.4	314.9	5.86	4.80	6.34	6.95	7.17	6.60	7.30	7.70	7.70	7.70
Minus intermediate machinery production	54.1	58.0	61.3	66.8	72.1	78.2	84.3	91.8	100.4	109.8	120.0	7.18	5.72	9.04	7.89	8.49	7.81	8.93	9.34	9.34	9.34
Equals final machinery production	108.9	114.6	119.6	125.5	133.6	142.2	150.6	160.3	171.1	182.6	194.9	5.20	4.33	4.95	6.46	6.45	5.94	6.39	6.76	6.74	6.72
Minus consumer durables machinery production	19.8	20.9	20.6	21.5	22.7	24.0	25.6	26.8	28.1	29.5	31.0	5.39	−1.62	4.49	5.59	5.83	6.70	4.62	5.01	5.01	5.02
Minus capital repair of civilian machinery	10.4	11.0	11.6	12.3	13.0	13.9	14.7	15.5	16.3	17.2	18.2	6.76	5.01	6.27	5.06	7.19	5.53	5.51	5.49	5.52	5.55
Equals investment and defense (I&D) machinery	78.7	82.7	87.4	91.7	97.9	104.3	110.4	118.0	126.7	135.9	145.7	4.95	5.74	4.89	6.85	6.50	5.81	6.91	7.33	7.28	7.23
Minus domestic defense machinery production:																					
Historical trend (9.63 percent annual growth)	31.5	32.6	37.3	39.6	44.1	48.7	53.3	58.5	64.1	70.3	77.1	3.55	14.50	6.15	11.44	10.29	9.63	9.63	9.63	9.63	9.63
Low trend (4.82 percent annual growth)							51.0	53.5	56.0	58.7	61.6						4.82	4.82	4.82	4.82	4.82
Equals domestic investment machinery production:																					
Historical trend of defense machinery production	47.3	50.1	50.1	52.1	53.8	55.7	57.0	59.5	62.5	65.6	68.6	5.88	.05	3.95	3.35	3.40	2.48	4.37	5.07	4.87	4.66
Reduced growth of defense machinery production							59.4	64.5	70.6	77.1	84.1						6.68	8.71	9.40	9.23	9.07
Plus net imports of investment machinery goods:																					
Historical trend of defense machinery production	6.6	6.5	9.2	11.3	10.4	10.7	10.8	11.6	12.5	13.4	14.4	−1.25	41.03	23.05	−7.92	2.19	1.68	7.23	7.32	7.40	7.48
Reduced growth of defense machinery production							10.8	11.6	12.5	13.4	14.4						1.68	7.23	7.32	7.40	7.48

Imports of investment machinery goods:																					
Historical trend of defense machinery production	13.0	12.6	15.5	18.0	17.4	18.0	18.3	19.5	20.9	22.3	23.9	−2.69	22.48	16.22	−3.06	3.16	1.66	6.84	6.90	6.95	7.01
Socialist imports	7.3	7.6	8.4	9.4	10.3	11.6	11.5	12.1	12.7	13.4	14.0	4.00	10.68	12.68	8.86	12.45	−.27	5.00	5.00	5.00	5.00
Nonsocialist imports	5.7	5.0	7.1	8.5	7.1	6.4	6.7	7.4	8.1	9.0	9.9	−11.25	40.19	20.42	−16.27	−10.25	5.14	10.00	10.00	10.00	10.00
Reduced growth of defense machinery production							18.3	19.5	20.9	22.3	23.9						1.66	6.84	6.90	6.95	7.01
Socialist imports							11.5	12.1	12.7	13.4	14.0						−.27	5.00	5.00	5.00	5.00
Nonsocialist imports							6.7	7.4	8.1	9.0	9.9						5.14	10.00	10.00	10.00	10.00
Exports of investment machinery goods	6.4	6.1	6.3	6.7	7.0	7.3	7.4	7.9	8.4	8.9	9.5	−4.18	2.65	6.19	5.22	4.60	1.63	6.27	6.28	6.29	6.30
Socialist exports	4.3	3.9	3.8	3.7	4.0	4.4	4.7	5.1	5.4	5.8	6.2	−9.74	−3.48	−2.61	9.20	10.69	7.00	7.00	7.00	7.00	7.00
Nonsocialist exports	2.0	2.2	2.5	3.0	3.0	2.9	2.7	2.8	3.0	3.1	3.3	7.53	13.49	19.43	.33	−3.53	−6.59	5.00	5.00	5.00	5.00
Equals investment machinery goods supply:																					
Historical trend of defense machinery production	53.9	56.6	59.3	63.4	64.2	66.3	67.9	71.1	75.0	79.0	83.0	5.01	4.77	6.91	1.34	3.20	2.35	4.83	5.43	5.29	5.14
Reduced growth of defense machinery production							70.2	76.2	83.1	90.5	98.5						5.88	8.48	9.09	8.96	8.84
Inventory change/unidentified source:																					
Historical trend of defense machinery production							9.4	14.4	18.2	22.7	27.8						53.07	26.67	24.29	22.48	
Reduced growth of defense machinery production							7.1	9.4	10.2	11.1	12.3						32.73	8.36	9.40	10.40	
Inventory change/unidentified source as percent of I&D machinery production:																					
Historical trend of defense machinery production							8.5	12.2	14.4	16.7	19.0										
Reduced growth of defense machinery production							6.4	7.9	8.0	8.2	8.4										

Note.—Demand for investment goods (total investment and subcategory investment) is determined according to official Soviet investment targets, which are described in greater detail in table 2.
Supply of investment goods is derived as follows:
a. Gross machinery output—projected using official Soviet targets for MBMW output.
b. Intermediate machinery output—historical ratio of intermediate to gross machinery output forecasted and multiplied by gross machinery output.
c. Consumer durables—historical ratio of consumer durables to gross machinery output forecasted and multiplied by gross machinery output.
d. Capital repair—historical ratio of capital repair to gross aid-year capital stock forecasted and multiplied by gross aid-year capital stock.
e. Domestic defense machinery production—projected using growth rates determined by examination of historical trend over 1976–1985.
f. Imports and exports of investment machinery goods—projected using growth rates determined according to evident Soviet expectations of trade possibilities.
g. Inventory change/unidentified source—residual : total demand for investment goods minus total supply of investment goods.

What this table shows quite clearly is that an imbalance in the demand for and supply of machinery, represented by the variable "inventory change/unidentified source" in the table, develops over 1986–90, with demand consistently exceeding supply. With a historical trend of defense machinery production assumed, the imbalance is 8.5 percent of investment and defense machinery production in 1986, and 27.8 percent in 1990. Cutting the growth of defense machinery production by half to 4.6 percent reduces the size of the implied inventory drawdown but still leaves it quite high. Although there is undoubtedly room to draw down on inventories of equipment and machinery, which are believed to be rather large, this source of additional supply could reasonably be expected to last only one to two years (1986–87); inventories are a "nonrenewable resource". It is inconceivable that inventories could supply the projected amount of deficit machinery of even the low defense scenario in 1987–90. It also appears unlikely that the Soviets could squeeze consumer durables or capital repair, as the forecasted imbalance is simply too large. Therefore, it appears that the Soviet investment plan is inconsistent in yet another aspect, that of machinery produced by the economy and needed by the economy. It is important to note that this imbalance is created primarily by the rapidly growing share of investment in E&M in total investment.

Thus, we feel that the Soviet investment plan as it has been made known to Western analysts is inconsistent and infeasible for the following reasons:

A. Unrealistically low five-year plan targets for investment growth (as discussed in section II), and an unrealistic dynamic pattern for this growth.

B. Overly optimistic rise in ratio of investment in E&M to total investment.

C. Imbalance in demand for and supply of machinery due in large part to rapid growth of that ratio.

D. Implied squeeze on nonproductive investment.

E. Excessively low growth of investment in the energy/fuels complex.

By definition unrealistic plans are not implemented, and the interesting question is what in fact will happen to close the gap between supply and demand? The traditional Soviet solution is a shortfall in all targets for the investment program. In an effort to simulate such a result, we postulated the following outcomes for 1986–90, which allow Soviet leaders to move in the direction they seek, but not as far as they hope:

total investment grows 35.7 percent over 1986–90, rather than 23.4 percent, and growth is spread more evenly over the period;

the ratio of investment in E&M to total investment grows from 38 percent to 45.5 percent by 1990, rather than 50 percent;

investment in the MBMW complex grows 15.7 percent in 1986 as opposed to 30 percent, and 12 percent per annum over 1987–90 as opposed to 8.51 percent;

investment in the energy/fuels complex grows 58.5 percent over 1986–90 as opposed to 35 percent.

TABLE 4.—SOVIET INVESTMENT IN FIXED CAPITAL: ACTUAL AND AUTHORS' PROJECTION

Billion rubles, 1984 prices

	Actual						Projected					Year-to-year growth rates					Projected				
	1980	1981	1982	1983	1984	1985	1986[a]	1987[a]	1988[a]	1989[a]	1990[a]	1981	1982	1983	1984	1985	1986	1987	1988	1989	1999
Investment by type:																					
Total	150.9	156.5	161.9	171.0	174.3	179.5	193.0	204.6	216.9	229.9	243.7	3.71	3.45	5.62	1.93	2.98	7.52	6.00	6.00	6.00	6.00
Plant and structures	82.7	84.4	86.0	89.6	90.5	91.7	96.0	98.3	100.3	102.1	103.7	2.06	1.90	4.19	1.00	1.33	4.69	2.37	2.10	1.80	1.47
Machinery and equipment	53.9	56.6	59.3	63.4	64.3	67.6	75.0	82.7	91.1	100.5	110.8	5.01	4.77	6.91	1.42	5.13	10.95	10.24	10.24	10.24	10.24
Project design	2.7	2.4	2.4	2.4	2.5	2.6	2.9	3.2	3.5	3.8	4.1	−11.11	.00	.00	4.17	4.00	11.54	9.34	9.42	9.31	9.21
Other investment expenditures	11.6	13.1	14.2	15.6	17.0	17.6	19.1	20.5	21.9	23.4	25.1	12.93	8.40	9.86	8.97	3.53	8.52	7.11	7.06	7.05	7.04
Investment by complex:																					
Productive	111.2	115.0	118.6	124.9	126.5	129.8	140.7	149.8	159.2	169.3	180.4	3.42	3.13	5.31	1.28	2.61	8.40	6.48	6.42	6.34	6.59
Insustry, agriculture, and construction	89.1	91.8	94.3	98.4	99.0	103.1	112.1	119.4	127.2	135.7	145.2	3.03	2.72	4.35	.61	4.14	8.73	6.47	6.54	6.68	7.02
Fuels and energy complex	17.4	18.9	20.2	21.3	22.2	25.3	28.1	30.8	33.6	36.6	40.1	8.62	6.88	5.45	4.23	13.96	11.07	9.61	9.09	8.93	9.56
Metallurgy complex	5.2	5.7	6.0	6.3	6.0	5.9	6.6	7.0	7.6	8.1	8.7	9.62	5.26	5.00	−4.76	−1.67	11.86	6.80	7.21	7.20	7.18
Machinebuilding complex	13.1	13.6	13.7	14.6	14.9	15.9	18.4	20.6	23.1	25.9	29.0	3.82	.74	6.57	2.05	6.71	15.72	12.00	12.00	12.00	12.00
Chemicals and wood products complex	6.5	6.2	6.5	6.7	6.8	6.7	7.0	7.7	8.4	9.3	10.2	−4.62	4.84	3.08	1.49	−1.47	4.48	9.70	9.80	9.89	9.99
Construction complex	8.1	8.1	8.3	8.6	8.3	8.4	9.1	9.6	10.0	10.5	11.1	.00	2.47	3.61	−3.49	1.20	8.33	5.00	5.00	5.00	5.00
Light industry complex	2.0	2.1	2.1	2.3	2.3	2.2	2.3	2.5	2.7	3.0	3.2	5.00	.00	9.52	.00	−4.35	4.55	9.00	9.00	9.00	9.00
Agro-industrial complex	33.3	34.0	34.5	36.0	35.1	35.3	36.9	37.3	37.6	38.0	38.4	2.10	1.47	4.35	−2.50	.57	4.53	1.00	1.02	1.04	1.06
Other industry	3.5	3.2	3.0	2.6	3.4	3.4	3.7	3.9	4.1	4.3	4.5	−8.57	−6.25	−13.33	30.77	.00	8.82	5.00	5.00	5.00	5.00
Transport and communications	18.1	18.9	19.9	21.4	22.6	21.9	23.8	25.0	26.2	27.6	28.9	4.42	5.29	7.54	5.61	−3.10	8.68	5.00	5.00	5.00	5.00
Nonproductive	39.7	41.5	43.3	46.1	47.8	49.7	52.3	54.8	57.7	60.6	63.2	4.53	4.34	6.47	3.69	3.97	5.23	4.71	5.34	5.06	4.34

[a] The authors have projected growth rates over 1986–90 for total investment, investment in equipment and machinery, and investment in the energy/fuel and MBMW complexes which differ from officially planned targets. For further discussion, please see text.

The results for the implied investment accounts are shown in Table 4, and the resulting machinery balance is presented in Table 5. In addition to the alternative investment assumptions that affect demand for investment machinery in Table 5, additional alternative forecasts of key variables in this balance were made. An optimistic path for capital productivity in the MBMW sector and a forecast of capital stock levels in that sector were used to derive yearly gross machinery production over 1986–90. The annual levels of this source of machinery supply are actually slightly higher than the Soviet targets for gross machinery output (used in Table 3). A more realistic forecast of the ability of Eastern Europe to contribute to the Soviet modernization drive is reflected in the lowered growth rates of socialist imports of investment machinery, and in the case of the low defense machinery production scenario, the growth rate of nonsocialist imports of investment machinery has been halved (from 10 percent to 5 percent).

Even with these changes, Table 5 shows a sizable imbalance between machinery supply and demand. Thus, even under revised investment assumptions, we are unable to arrive at a feasible path for the Soviet economy over 1986–90.

TABLE 5.—SOVIET MACHINERY BALANCE (RECONSTRUCTED INVESTMENT DATA)

Billion rubles, 1984 prices

	Historical						Projected					Historical					Projected				
	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
DEMAND FOR INVESTMENT MACHINERY GOODS																					
Gross total investment in fixed capital	150.9	156.5	161.9	171.0	174.3	179.5	193.0	204.6	216.9	229.9	243.7	3.71	3.45	5.62	1.93	2.98	7.52	6.00	6.00	6.00	6.00
Minus gross investment in structures	82.7	84.4	86.0	89.5	90.5	91.2	96.0	98.3	100.3	102.1	103.7	2.06	1.90	4.07	1.12	.77	5.26	2.37	2.10	1.80	1.47
Minus other investment expenditures	14.3	15.5	16.6	18.0	19.5	21.0	22.0	23.6	25.4	27.2	29.2	8.39	7.10	8.43	8.33	7.69	4.76	7.40	7.38	7.36	7.34
Equals gross investment in machinery and equipment	53.9	56.6	59.3	63.4	64.3	66.6	75.0	82.7	91.1	100.5	110.8	5.01	4.77	6.91	1.42	3.58	12.61	10.24	10.24	10.24	10.24
SUPPLY OF INVESTMENT MACHINERY GOODS																					
Gross machinery production	163.0	172.5	180.8	192.3	205.7	220.4	241.8	258.3	277.1	298.2	321.9	5.86	4.80	6.34	6.95	7.17	9.69	6.83	7.28	7.62	7.95
Minus intermediate machinery production	54.1	58.0	61.3	66.8	72.1	78.2	86.8	94.1	102.5	111.9	122.7	7.18	5.72	9.04	7.89	8.49	10.94	8.45	8.91	9.26	9.59
Equals final machinery production	108.9	114.6	119.6	125.5	133.6	142.2	155.0	164.2	174.6	186.2	199.2	5.20	4.33	4.95	6.46	6.45	9.01	5.92	6.34	6.66	6.97
Minus consumer durables machinery production	19.8	20.9	20.6	21.5	22.7	24.0	26.3	27.4	28.7	30.1	31.7	5.39	−1.62	4.49	5.59	5.83	9.73	4.17	4.61	4.94	5.26
Minus capital repair of civilian machinery	10.4	11.0	11.6	12.3	13.0	13.9	14.6	15.4	16.2	17.1	18.1	6.76	5.01	6.27	5.06	7.19	5.08	5.51	5.49	5.52	5.55
Equals investment and defense (I&D) machinery	78.7	82.7	87.4	91.7	97.9	104.3	114.1	121.4	129.7	139.0	149.4	4.95	5.74	4.89	6.85	6.50	9.37	6.37	6.85	7.19	7.51
Minus domestic defense machinery production:																					
Historical trend (9.63 percent annual growth)	31.5	32.6	37.3	39.6	44.1	48.7	53.3	58.5	64.1	70.3	77.1	3.55	14.50	6.15	11.44	10.29	9.63	9.63	9.63	9.63	9.63
Low trend (4.82 percent annual growth)							51.0	53.5	56.0	58.7	61.6						4.82	4.82	4.82	4.82	4.82
Equals domestic investment machinery production:																					
Historical trend of defense machinery production	47.3	50.1	50.1	52.1	53.8	55.7	60.7	62.9	65.5	68.7	72.4	5.88	.05	3.95	3.35	3.40	9.14	3.51	4.26	4.80	5.34
Reduced growth of defense machinery production							63.1	67.9	73.6	80.2	87.8						13.35	7.63	8.44	8.99	9.48

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TABLE 5.—SOVIET MACHINERY BALANCE (RECONSTRUCTED INVESTMENT DATA)—Continued

Billion rubles, 1984 prices

	Historical						Projected					Historical					Projected				
	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Plus net imports of investment machinery goods:																					
Historical trend of defense machinery production	6.6	6.5	9.2	11.3	10.4	10.7	10.8	11.1	11.3	11.5	11.8	−1.25	41.03	23.05	−7.92	2.19	1.68	2.49	2.20	1.64	2.03
Reduced growth of defense machinery production							10.8	10.1	9.4	8.8	8.1						1.68	−6.52	−6.82	−7.19	−7.62
Imports of investment machinery goods:																					
Historical trend of defense machinery production	13.0	12.6	15.5	18.0	17.4	18.0	18.3	19.0	19.7	20.5	21.3	−2.69	22.48	16.22	−3.06	3.16	1.66	4.03	3.90	3.62	3.89
Socialist imports	7.3	7.6	8.4	9.4	10.3	11.6	11.5	11.6	11.6	11.5	11.4	4.00	10.68	12.68	8.86	12.45	−.27	.54	.00	−.86	−.87
Nonsocialist imports	5.7	5.0	7.1	8.5	7.1	6.4	6.7	7.4	8.1	9.0	9.9	−11.25	40.19	20.42	−16.27	−10.25	5.14	10.00	10.00	10.00	10.00
Reduced growth of defense machinery production							18.3	18.0	17.8	17.7	17.6						1.66	−1.31	−1.08	−.84	−.59
Socialist imports (faster decline)							11.5	11.0	10.4	9.9	9.4						−.27	−5.00	−5.00	−5.00	−5.00
Nonsocialist imports (modest borrowing)							6.7	7.1	7.4	7.8	8.2						5.14	5.00	5.00	5.00	5.00
Exports of investment machinery goods	6.4	6.1	6.3	6.7	7.0	7.3	7.4	7.9	8.4	8.9	9.5	−4.18	2.65	6.19	5.22	4.60	1.63	6.27	6.28	6.29	6.30
Socialist exports	4.3	3.9	3.8	3.7	4.0	4.4	4.7	5.1	5.4	5.8	6.2	−9.74	−3.48	−2.61	9.20	10.69	7.00	7.00	7.00	7.00	7.00
Nonsocialist exports	2.0	2.2	2.5	3.0	3.0	2.9	2.7	2.8	3.0	3.1	3.3	7.53	13.49	19.43	.33	−3.53	−6.59	5.00	5.00	5.00	5.00
Equals investment machinery supply:																					
Historical trend of defense machinery production	53.9	56.6	59.3	63.4	64.2	66.3	71.6	74.0	76.9	80.2	84.1	5.01	4.77	6.91	1.34	3.20	7.94	3.36	3.95	4.34	4.86
Reduced growth of defense machinery production							73.9	78.0	83.1	89.0	95.9						11.47	5.55	6.46	7.16	7.80
Inventory change/unidentified source:																					
Historical trend of defense machinery production							3.4	8.7	14.3	20.3	26.6						154.00	63.71	42.09	31.54	
Reduced growth of defense machinery production							1.1	4.7	8.1	11.5	14.8						329.08	73.50	41.91	29.19	

Inventory change/unidentified source as percent of I&D machinery production:						
Historical trend of defense machinery production	3.0	7.2	11.0	14.6	17.8	
Reduced growth of defense machinery production	1.0	3.8	6.2	8.3	9.9	

Note.—Demand for investment goods (total investment and subcategory investment) is determined according to authors' reconstructed investment balance, which is described in greater detail in table 4.
Supply of investment goods is derived as follows:
a. Gross machinery output—historical capital/output ratio in MBMW sector forecasted based on historical trend during 1976–85, and multiplied by mid-year capital stock in MBMW sector.
b. Intermediate machinery output—historical ratio of intermediate to gross machinery output forecasted and multiplied by gross machinery output.
c. Consumer durables—historical ratio of consumer durables to gross machinery output forecasted and multiplied by gross machinery output.
d. Capital repair—historical ratio of capital repair to gross mid-year capital stock forecasted and multiplied by gross mid-year capital stock.
e. Domestic defense machinery production—projected using growth rates determined by examination of historical trend over 1976–85.
f. Imports and exports of investment machinery goods—projected using growth rates determined by PlanEcon forecast of trade possibilities.
g. Inventory change/unidentified source—residual: total demand for investment goods minus total supply of investment goods.

III. Implications of the Investment Crunch for the Economy

The implications of these explorations with the machinery balance are that the entire FYPXII, not simply the investment plan, may be infeasible. The final outcome, different from the plan, will involve new trade-offs between investment, consumption, and defense. To analyze the nature of those trade-offs, we shall utilize SOVECON, a macro model with an endogenous machinery balance, which is particularly useful in explaining the medium-term implications of various trade-offs among final demand aggregates.

A. A brief description of the SOVECON model

SOVECON is explicitly designed to model medium- to long-term trends of the Soviet economy; there is no attempt to forecast short-term (1–3 year) cycles. It contains no behavioral relationships (unlike other models of the Soviet economy such as SOVMOD). The few estimated econometric relationships are either technical (such as capital formation equations) or involve the regression of a variable on time trends. Thus, the model is primarily an accounting tool driven by a few key forecasting equations, and model dynamics are relatively easy to understand. Because the model is primarily an accounting framework, it is easy to generate alternative scenarios by changing the roles of endogenous and exogenous variables. Finally, SOVECON has been estimated from Soviet data and produces forecasts of values of Soviet variables such as net material product produced and used. No reconstructed data from Western sources (such as CIA estimates of Soviet GNP) have been used in SOVECON's development. Thus, the model is ideally suited to test Soviet five-year plans, as targets given in those plans are directly applicable to the variables forecasted by the model.

There are six producing sectors in SOVECON:

a. Machinebuilding and metalworking;
b. Energy;
c. Nonfood Raw Materials;
d. Agriculture and Food Processing;
e. Nonfood Industrial Consumer Goods;
f. Productive Services (Construction, Trade, Transport and Communications).

Each of these sectors is represented by a production function in which capital stock is the sole input. An exogenous level of capital productivity is multiplied by capital stock to determine output. Output levels of the MBMW, agricultural, nonfood industrial consumer goods, and productive services sectors determine the level of national income produced. Production of these sectors determines the levels of retail sales of food and nonfood consumer goods and gross investment, which determine national income used (defense machinery production also feeds into national income used, but the growth of this variable is set exogenously). Demand for energy and nonfood raw materials (strictly intermediate goods) is calculated, as well as for labor; actual supplies of these goods is compared with demand to observe emerging imbalances.

The MBMW sector is the heart of the SOVECON model. The final outputs of this sector include defense machinery production (determined exogenously by the analyst) and investment machinery

production. The latter output serves to determine total gross investment through multiplying investment machinery production by an exogenously forecasted share of investment in E&M in total investment. The distribution of gross investment across the six producing sectors is exogenous. In each sector gross total investment is converted into capital stock through sectoral capital formation equations. Thus, as capital stock is the only input factor in sectoral production functions, the analyst has the opportunity to observe various impacts on the economy by changing the defense burden or investment patterns, for example.

Trade flows also enter into each producing sector of the model (except for productive services) as nonsocialist and socialist trade. Trade balances in the socialist and nonsocialist sectors are exogenous. Exports are tied to sectoral output, whereas imports are tied to demand variables. Once the model generates demands for imports, this demand level is compared to the allowable level determined by the exogenous trade balances and level of exports. If the desired level of imports exceeds the allowable level, they are constrained. Thus, the level of nonsocialist or socialist imports is not strictly endogenous, but the shares of various import subcategories in total imports is endogenously determined. Whereas trade data could be collected from Soviet sources only in dollars and trade ruble values, conversion ratios were derived which allows the conversion of these variables into domestic ruble values.[4]

The construction of SOVECON required the collection of the historical data on the Soviet economy for the period 1960–85.[5]

Because capital productivity is exogenous, we have the opportunity to experiment with the model to discover what sorts of productivities are necessary for the Soviets to meet their plans for net material product (NMP) produced and used, total investment, and consumer goods production. It is very important to note that in our analysis of Soviet plan consistency in section III, the imbalance in the demand for and supply of machinery was allowed to exist. However, the model must force demand to equal supply, and in the SOVECON framework investment in equipment and machinery is a residual. Thus, *any imbalance in the demand for and supply of machinery will be absorbed by investment.* Therefore, if a large imbalance exists, investment will be low. One can mitigate the imbalance and increase investment by increasing the capital productivity (and hence gross machinery output) in the MBMW sector.

We have let any imbalance in the demand for and supply of machinery impact on the production of investment machinery. The Soviets could permit the imbalance to fall partially or wholly on the production of consumer durables (an MBMW sector output). If this happens, the growth of total investment would improve, but the growth of national income used would be the same as when the imbalance impacted in investment, in E&M, because growth of the personal consumption component of national income used would be lowered. Additionally, the target for consumer goods production

[4] More information on the derivation of conversion ratios from dollars or trade rubles to domestic rubles is available on request.

[5] More information on the model's structure and the historical data used to estimate the model's parameters can be found in Levine and Roberts, 1986.

would not be met, thus imperiling the Soviets' plans to increase consumer satisfaction and, indirectly, labor productivity.

An important point to consider is that if investment in equipment and machinery absorbs all the imbalance in the demand for and supply of machinery, and total investment falls as a result, sectoral outputs of goods and services are little affected in the formation equations. The investment shortage would be felt more keenly in the period 1990–2000. However, if the model included a labor supply function in which labor productivity depended on the supply of goods and services, and if the production functions had effective labor supply as an input, then letting the impact of the machinery imbalance fall on consumer durables would quickly affect labor supply and hence sectoral production.[6]

B. RESULTS FROM USING THE SOVECON MODEL

In our initial runs with SOVECON we concluded that FYPXII is so ambitious that it is inconceivable it will be fulfilled if defense machinery production grows at its historical rate. Therefore, we proceeded with our detailed simulations assuming only the "reduced growth" of defense machinery production discussed earlier.

Six scenarios were run on SOVECON, and a summary of results are given in table 6. The first three scenarios (A–C) use official Soviet investment targets, and the second three (I–III) use the authors' investment assumptions. Specifically, the share of investment in E&M in total investment was exogenously forecasted for scenarios A–C according to the Soviet plan and for scenarios I–III according to the authors' forecast (note that this is a key forecast, as it determines, in conjunction with available investment machinery, total investment), and the share of MBMW investment in total investment was made to correspond to the Soviet plan share for scenarios A–C and to the authors' forecasted share for scenarios I–III.

TABLE 6.—SUMMARY OF SOVECON MODEL SIMULATION RESULTS

[5-year growth rates, 1986–90]

	NMP produced	NMP used	Total investment	MBMW investment	Consumer goods production	MBMW output	Required capital productivity in MBMW
Soviet targets	24.6	22.1	23.6	80.0	26.9	43.0	1.2
Official Soviet investment shares scenarios:							
A. Historical sectoral productivities	13.5	2.6	7.0	45.4	10.8	37.9	−2.8
B. Planned sectoral productivities	24.7	14.4	12.8	53.6	25.1	45.1	1.2
C. Plan compatible sectoral productivities	28.4	20.1	23.3	68.2	27.5	55.7	5.9
Authors' investment shares scenarios:							
I. Historical sectoral productivities	14.4	5.6	11.8	38.8	12.1	35.9	−2.8
II. Planned sectoral productivities	27.6	20.6	17.8	46.5	30.9	43.0	1.2

[6] At present, the model is unable to simulate this process. Many attempts were made to estimate a labor supply function when SOVECON was built; all were unsuccessful. Recent work has involved attempts to estimate Cobb-Douglas production functions for the six producing sectors, and in three cases the results were unacceptable. Successful estimation of production functions for this model will likely involve the use of Bayesian techniques.

TABLE 6.—SUMMARY OF SOVECON MODEL SIMULATION RESULTS—Continued

[5-year growth rates, 1986–90]

	NMP produced	NMP used	Total investment	MBMW investment	Consumer goods production	MBMW output	Required capital productivity in MBMW
III. Plan compatible sectoral productivities	28.6	22.0	21.6	51.2	31.7	45.3	2.0

Note.—Soviet targets taken from table 1. For explanation of investment share and scenario productivity assumptions, see text.

Additionally, scenarios A and I use historical trends in capital productivity in the six SOVECON producing sectors, scenarios B and II use sectoral capital productivities that are anticipated in the Soviet five-year plan,[7] and scenarios C and III use capital productivities identical to that for B and II except that capital productivity in the MBMW sector has been increased to the point where the Soviets can meet their targets for NMP used and total investment growth (recall that sectoral capital productivities are exogenous forecasts and, in conjunction with sectoral capital stock, determine sectoral outputs).

It is clear that if historical trends in Soviet productivity continue to 1990, the Soviets have no hope of meeting any of the targets laid out in the five-year plan. Even when using the more reasonable investment assumptions of the authors' forecast, the Soviet economy comes nowhere near fulfilling the plan for NMP produced and used, total investment, and consumer goods production.

If the Soviets can achieve the growth in sectoral productivities they have determined that they need in the plan, then according to the results of scenarios B and II they can fulfill or slightly exceed the plan for NMP produced and consumer goods production. In the case of scenario B, they fall far short of fulfilling the NMP used and total investment targets. In the case of scenario II, they come close to fulfilling the plan for NMP used but still come short of the total investment plan.

Finally, scenario C indicates that a tremendous burst of capital productivity in the MBMW sector is necessary (5.9 percent growth over 1986–90 as compared with 1.2 percent growth projected by the five-year plan and −2.8 percent growth based on historical trends) for the Soviets to come very close to meeting the NMP used and total investment plan. Scenario III indicates that with the more reasonable investment assumptions made by the authors, a much smaller growth is necessary (2.0 percent) to achieve the same result.

A general pattern emerges from these results: NMP produced growth is consistently much higher than NMP used growth, and MBMW output is either close to or exceeds the planned target.

[7] The Soviets have stated:

"For the first time in a number of five-year periods, a sharp increase in the effectiveness of capital investments is envisaged. The rate of decrease in return on assets in the national economy will be cut by more than 50 percent, and in the machinebuilding and light industry this negative tendency of many year's standing will be completely overcome." (Ryzhkov 1986)

We accordingly halved increases in the capital-output ratios for all sectors except MBMW and light industry. The ratio in light industry was given zero percent growth over 1986–90, and the ratio in MBMW was given a −0.25 percent decrease per annum.

First, model results are consistently characterized by high growth of production in the intermediate goods sectors (energy and raw materials) and much lower growth in the sectors which determine levels of national income used. The agriculture/food processing and nonfood consumer goods sectors grow at a fairly slow pace, and investment also grows slowly even though MBMW output might be growing quickly due to the process discussed above. The implication is that FYPXII will lead to structural imbalances in production and investment that result in the accumulation of inventories of intermediate goods and deficits of goods delivered to final demand. Second, very high growth is allocated to the share of investment in E&M in total investment in both the plan targets and the authors' forecasts. Whereas machinery production might rapidly climb, thus causing investment in E&M to also rise quickly, a rapidly rising share of investment in E&M in total investment will negate the impetus given to total investment by rapidly rising investment in E&M. Thus, total investment does not rise much even as machinery output does, and the plan for NMP used and total investment is underfulfilled even as the plan for machinery output and NMP produced is met or overfulfilled. The model is simply making too rigid a real complementarity in the Soviet economic system, that of investment in E&M to total investment.[8]

The scenario simulations serve to reinforce the argument that the XIIth five-year plan is inconsistent and infeasible. Aside from a burst of hidden inflation, which is entirely conceivable given the incentives emerging in Gorbachev's reforms, we cannot see how the main targets of the plan will be fulfilled. In the tests in section III, a large machinery shortage was shown to emerge over 1986–90; in this section, this inconsistency impacted in the model's framework by serving to hold down investment rates through suppressing available supply of investment machinery. The necessary sectoral productivity in the MBMW sector for NMP used and total investment targets to be met in either scenario C or III is not likely to be attained. In fact, all sectoral productivities projected by the five-year plan will be very difficult to achieve, as they represent an unprecedented departure from trends that have developed over the past twenty years. It could be that the Soviets anticipate a shortening of the lags in which investment is converted into producing capital stock and thus foresee a huge burst of capital coming on line over 1986–90. However, this is also an ambitious target which would require major changes in Soviet economic behavior.

It is not the intention of this paper to assess the ability of Gorbachev's government to bring about sufficient change through economic reform or other measures in order that these productivity targets or changes in capital formation lags be met. However, for this five-year plan to be feasible, such change must occur very quickly and must be sustained over the entire period. Any productivity gains that are brought about by increased worker discipline and installation of unused equipment are short-term gains only,

[8] This feature can be attributed to the manner in which gross investment is derived in the model; no mechanism has been built in that allows for a lowering of the share of investment in E&M in total investment if total investment is very low, and we hope to incorporate an algorithm that would do this in SOVECON in the future to simulate more realistically actual economic processes.

and must be followed by improved technological responsiveness and other changes which will ensure long-term productivity increases. Such long-term changes will be more difficult to bring about than short-term changes. Similarly, any shortening of investment lags brought about in the short run by decrees from above and greater managerial discipline must be sustained in future by fundamental changes in the Soviet system that encourage such efficient behavior.

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GORBACHEV AND THE ECONOMY: THE DEVELOPING GAMEPLAN

By Douglas Kreshover*

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SUMMARY

Gorbachev realizes that turning the economy around is a difficult and long range task. He has outlined very ambitious growth goals, but has yet to develop a consistent plan of action to achieve them. Many of the policies unveiled to date are repeats or extensions of past ideas. What is new is the vigor with which the current program is being pushed. Over the next few years more dynamic leadership and mobilization of effort may prompt faster rates of economic growth, even if Gorbachev's high priority industrial modernization program gets off to a slow start or falters. Still, industrial modernization is the key to Gorbachev's ultimate success or failure. If his modernization program does not result in the development, production and assimilation of substantial quantities of high quality, sophisticated equipment, the gap between Western and Soviet technology is likely to widen during the 1990's. This could bring increased risk to the General-Secretary's power and authority, especially as the military leadership grows increasingly impatient with the lack of progress and the lack of an increased resource commitment.

Gorbachev, who is now engaging in a fair amount of improvization, probably hopes to have a comprehensive and detailed gameplan in place by the end of the decade to be implemented during the 13th and 14th Five-Year periods (1991–2000). In the meantime, he will most likely keep his options open; trying a variety of policies—keeping what works and rejecting what doesn't. Gorbachev is developing policies to help the existing system better meet its potential, but his sanctioning of debate on such sensitive economic

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issues as bankruptcy, unemployment and prices more reflective of market forces indicates that he is keeping the door open to the possibility of systemic reform should he view it as necessary and feasible in the future.

I. Setting the Scene

In the 21 months since becoming General-Secretary, Gorbachev has made it clear that economic re-vitalization is the primary goal of his regime. The new Soviet leader has inherited an economy where total factor productivity continues to decline, despite attempts since the early 1970's to improve efficiency and offset the drag caused by a slower growing labor force and the spiralling costs of critical fuels and raw materials. Even though industrial performance has improved somewhat during the last couple of years, Gorbachev believes that economic growth must accelerate far above its 2 percent average annual growth of 1981–85 to adequately address the increasing demands of defense and the consumer while generating enough investment to re-tool the country's obsolescing industrial base. He seems to realize that achieving such rapid growth will require substantial improvements in the economy's capability to create and use new technologies.

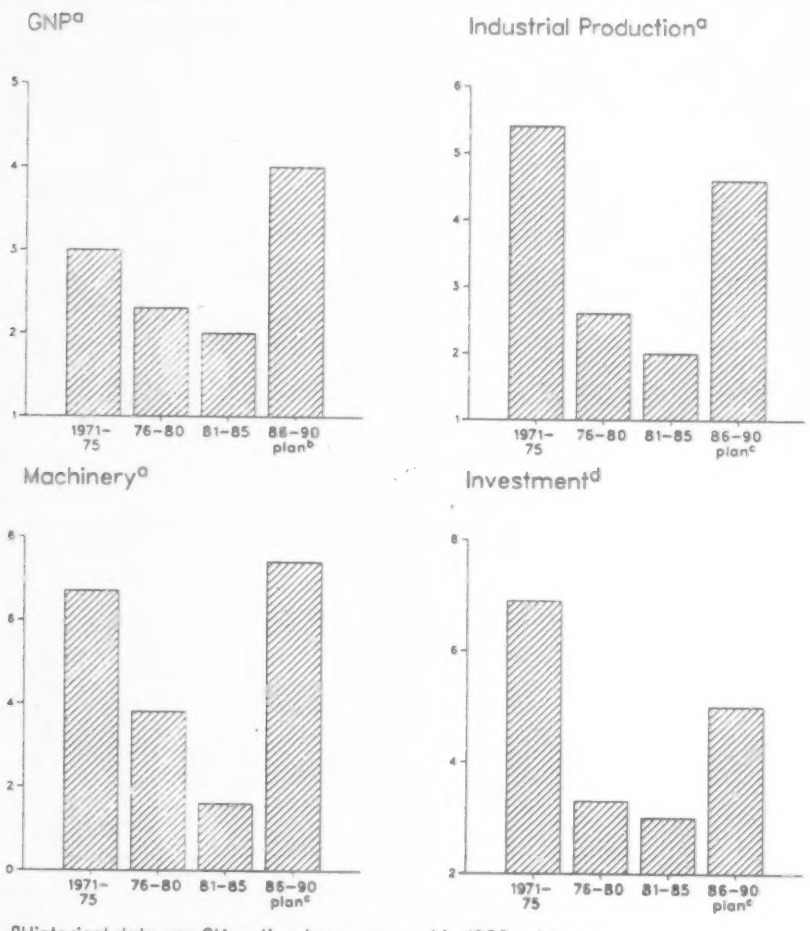
II. Ambitious Goals

The imperative of accelerated economic growth is made clear in the economic plan for 1986, the economic plan for 1987, and the Five-Year Plan for 1986–90 with guidelines to the year 2000 (see figure 1). The economy is to grow at an average annual pace of about 4.5 percent during 1986–2000—4 percent for the rest of this decade, followed by rates greater than 5 percent during the 1990's. Growth in the vital industrial sector is to follow much the same pattern rising from the 2 percent average annual pace of 1981–85 to 4.6 percent in 1986–90 and then faster in the 1990's. Both investment and machinery production—critical forces to push economic growth—are to increase at an average annual pace during the 12th Five-Year period that is substantially higher than achieved over the past decade.[1] All output gains are to come from increased labor productivity—high and accelerating rates of economic growth must be achieved with no growth in labor inputs. Such "intensive" growth is not a new goal, but past campaigns to improve productivity have been largely ineffective.

[1] See *Pravda*, 4 March 1986 and 19 June 1986.

Jan 8, 1987

Figure 1
Selected Indicators of Economic Performance, 1971–1990
(Average annual growth rates)



[a]Historical data are CIA estimates expressed in 1982 prices.
[b]CIA estimate of GNP growth necessary to achieve Soviet planned national income growth. The principle conceptual difference between GNP and the Soviet measure of national income is the latter's exclusion of most services and depreciation on fixed capital.
[c]Official Soviet plan goal.
[d]Historical data are official Soviet statistics.

III. Overall Strategy

The published economic plans, as well as past speeches by Gorbachev and his lieutenants, suggest a three phase strategy to achieve these ambitious growth goals:

PHASE I

The lethargic economy is to receive an immediate boost through the more efficient use of existing resources—primarily renewed emphasis on discipline, temperance, less waste, conservation of fuels, metals and other materials, improved worker effort, and placement of allies into key management positions in the economic bureaucracy. Additional gains are to come gradually from organizational changes—most notably the various measures to speed innovation by bringing R&D closer to the production line and the "coordinating bodies" to improve management and performance in the key sectors of machine building, energy, construction, agriculture and foreign trade. Performance also is to be aided by the industry-wide adoption in 1987 of the industrial management experiment begun in 1984 that gives more operational autonomy to enterprises. Furthermore, ministries are to be gradually moved to a system of self-financing where their enterprises pay a percentage of profits to the state and finance their operations without support from the central budget. These individual behavior and institutional adjustments—human factors—are supposed to contribute almost ⅓ of the labor productivity increase planned to support economic growth over the next five years (see figure 2).[2]

[2] See "Basic Guidelines for the Economic and Social Development of the USSR for 1986-90 and the Period Through the Year 2000", *Pravda*, 9 March 1986.

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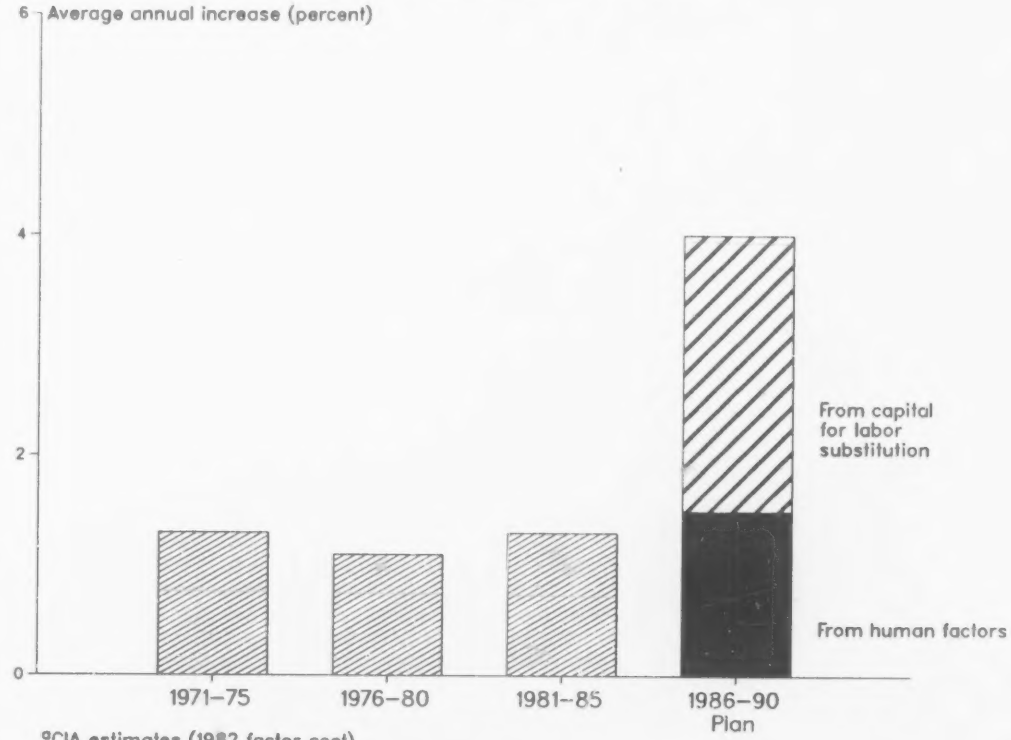
Figure 2
USSR: Growth in Labor Productivity[a]



[a]CIA estimates (1982 factor cost).

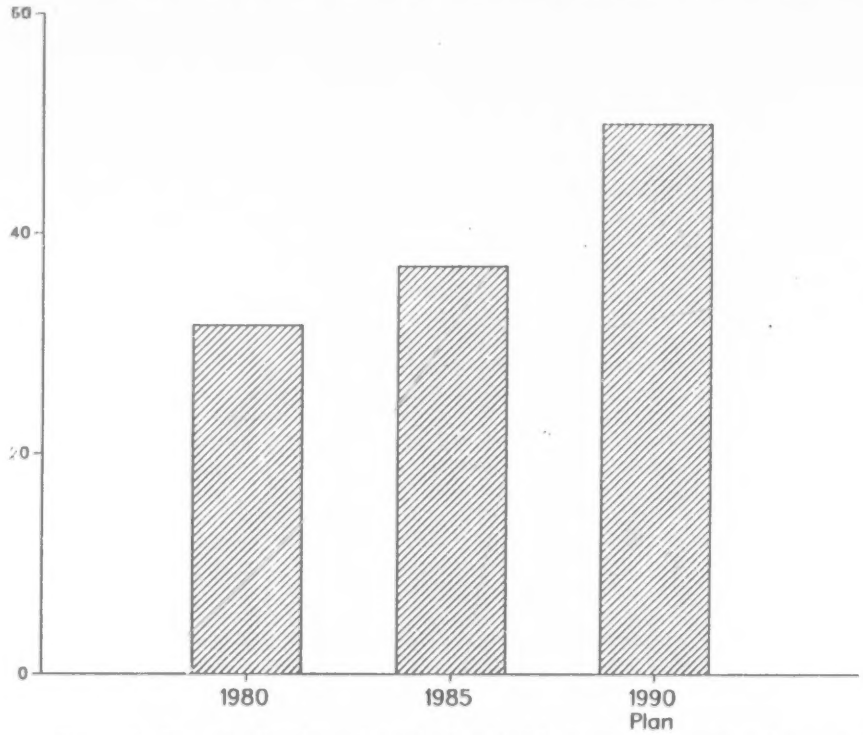
PHASE II

More than two-thirds of the planned increase in economic output during 1986–90 is to be achieved by substituting new machinery for labor—especially in relatively low technology activities that employ large numbers of manual workers such as materials handling. In his speech to the 27th Party Congress in March, 1986 Prime Minister Ryzhkov indicated that such substitution would have an impact equivalent to adding 20 million people to the work force by 1990. With the work force expected to increase by only about 3.2 million people during 1986–90, this substitution—if successful—would provide the major source of economic growth for the rest of the 1980's.[3] To implement this strategy Gorbachev intends to increase the share of investment resources going to plant renovation, rather than new construction. Rubles that in the past were spent erecting buildings and structures will now be redirected toward re-tooling existing facilities with new machinery (see figure 3).

[3] For labor force projections, see Stephen Rapawy and W. Ward Kingkade, "Estimates and Projections of the Labor Force and Civilian Employment in the USSR: 1950–2000", Center for International Research, Bureau of the Census, Washington, D.C., September, 1986, p. 7.

Dec 9, 1986

Figure 3
Ambitious Goals for Increasing Investment in Renovation



Percent of productive investment allocated to re-equipment and renovation.

PHASE III

Gorbachev bases his hopes for further increasing growth in the 1990's on the success of the "Scientific and Technological" revolution he envisions for the economy. He made this clear shortly after becoming General-Secretary, declaring in April 1985 that "S&T progress in the majority of industries is flagging; developing in an evolutionary way when what is needed is revolutionary change." [4] In other words, simply improving existing technologies will not recapture past rates of rapid economic growth and may jeopardize the economy's capability to match the quickening pace of productivity gains in the industrial West. To achieve an S&T Revolution Gorbachev has ordered a crash program to re-tool civilian machine building—the sector that must produce the new and better equipment necessary to modernize the rest of industry. During the 12th Five-Year Plan period investment in civilian machinebuilding and metalworking (MBMW) is scheduled to increase by 80 percent over its 1981–85 level.[5] Special emphasis will go to the same high-tech areas of MBMW that are leading modernization campaigns in the West—the machine tool, computer, electro-technical and electronics industries. Gorbachev hopes that large investments in these industries today will pay back in the 1990s with increasing output of high-technology equipment to modernize the economy.

IV. From Strategy to Implementation—Missing Links

Published economic plans and speeches of the leadership give the impression that Gorbachev has not developed a detailed blueprint to implement his economic strategy. Moreover, the plans and speeches are marked by questionable linkages, omissions, and in some cases inconsistencies that may indicate ongoing debate and tension about appropriate economic policies.

—Plans for long-term growth rely largely on a re-tooled industry—by 1990 about one-third of the present stock of machinery is to be "new"—but the ambitious industrial output goals for 1986–90 do not allow for the necessary down-time for enterprises to install new equipment and learn to use it.

—The plans for rapid acceleration of machinery output conflict with plans for breakthroughs in machinery quality. Machines that are "new" and "revolutionary" cannot be developed, produced and assimilated in a hurry.

—Moscow has announced that enterprises are to be given greater scope for decisionmaking, but has also made it clear through recent firings that Ministry and Party officials continue to be held responsible for enterprise performance. As a result, these officials are unlikely to willingly relinquish much of their operational control. And even if they did, it is still not clear that enterprise performance—measured by output and quality criteria—would improve without overhauling incentives and changing the price system.

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[4] Mikhail Gorbachev in speech at a plenary meeting of the CPSU Central Committee on 23 April, 1985.

[5] Report by N. Ryzhkov, "On the State Plan for Economic and Social Development of the USSR for 1986–90", *Pravda*, 19 June 1986, p. 2.

—The plans imply that Siberia will continue to be developed on a priority basis, while at the same time resources for new construction—vitally needed in Siberia—will be cut back drastically throughout the economy. However, the continued planned development of Siberia's energy resources will require massive new construction—an "extensive" growth project at direct odds with the "intensive" growth strategy.

—The Five-Year Plan goals for saving energy, metals, and other materials are sharply higher than the lower levels of savings realized during 1981–85. Their achievement would require substantial changes in the energy and metal intensity of the capital stock, but the long lead times necessary to design and produce energy- and material-efficient equipment make it highly unlikely that greatly increased savings could be realized this decade.

—The published economic plans imply ambitious goals for increased production of consumer goods, but Premier Ryzhkov suggested in his speech to the 27th Party Congress some reduced priority for the consumer when he said the share of consumption in national income will fall in 1986–90.[6]

—The investment target of the 1986 plan is sharply higher than investment planned for 1987 and the average annual pace scheduled for the 1986–90 period. If the 1986 target is achieved, investment will have to slow considerably during 1987–90 to stay within the Five-Year Plan guidelines. However, the targets for machinery output—the main provider of investment goods needed for industrial modernization—indicate faster growth in 1987–90 than in 1986, a pattern not consistent with slower growth of investment.

—The Five-Year Plan goal for growth in energy investment of about 6 percent per year is clearly out of line with the investment growth targets in the 1986 plan of 31 percent for oil extraction, 27 percent for coal and 24 percent for electric power.[7]

Besides apparent inconsistencies and contradictions in the plans and speeches, important parts of Gorbachev's game plan have not been revealed. Notably limited are details of Moscow's plans for such critical areas as the branch structure of industrial investment and foreign trade.

While these omissions and contradictions suggest Gorbachev is having some difficulty figuring out how to achieve his goals, political obstacles may also be restricting the General-Secretary's capability to push his program. By the time Gorbachev entered office in March 1985 the drafting of the 1986–90 plan was far advanced. It is possible that after repeatedly remanding the Five-Year Plan for revisions, Gorbachev ran out of time before the March 1986 Party Congress and allowed publication of a Five-Year Plan for form's sake, with the intent of actually relying on annual plans to implement his own policies.

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[6] N. Ryzhkov, "Report on the Basic Guidelines for the Economic and Social Development of the U.S.S.R. for 1986–1990 and the Period through the Year 2000." *Pravda*, 4 March 1986.

[7] Speech on the 1986 plan by State Planning Committee Chairman N. Talyzin, *Izvestiya*, 27 November 1985.

Such a strategy also gives Gorbachev greater latitude to try a variety of policies—keeping what works and rejecting what doesn't. Moreover, it allows him to delay and perhaps avoid a hard decision over defense-civilian resource allocations. The military appears to have bought into Gorbachev's program to modernize the civilian economy—at least for the time being—out of the belief that defense will be a major long term beneficiary. Because of large investments in defense facilities over the last decade the military is well positioned to accommodate a shift in resources to civilian machine building over the next couple of years.[8] During the late 1980's, however, the Soviets will have to begin installing the new machinery in defense plants required to produce the weapons systems of the 1990's. If by that time Gorbachev's high priority industrial modernization program has not paid off with enough good, new machinery for both defense and civilian uses, he may have to make a hard, and politically risky, decision between guns and butter.

V. Emphasizing Better Implementation of Past Programs

Despite Gorbachev's rhetoric, which includes calls for "radical reform" and "profound transformations," many of his policies announced to date are repeats or extensions of past ideas. Modernizing industry by renovating plants instead of building new ones has been a high priority for more than 15 years. Organizational changes to strengthen the hands of central planners while giving more operational autonomy to enterprise managers, as well as to speed technological change by bringing R&D closer to the production line, have been tried in various forms since the Kosygin reforms of 1965. Even Gorbachev's call for a "scientific-technological" revolution is not new, but was a main Brezhnev theme.

What is notably new about Gorbachev's current program for the economy is the vigor with which it is being pushed. Gorbachev has already made impressive gains in replacing managerial deadwood throughout the economic bureaucracy with younger, handpicked allies. He has created an air of momentum and expectation that may enable him to be more successful than his predecessors in implementing the current brew of "old" policies (see below). Certainly, the level of waste and inefficiency in the Soviet economy is so high that Gorbachev's no-nonsense approach and dynamic management style could prompt significant increases in economic output—at least for awhile.

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[8] For further information see "Allocation of Resources in the Soviet Union and China—1985"; Hearing before the Subcommittee on Economic Resources, Competitiveness and Security Economics of the Joint Economic Committee; U.S. Congress, March 19, 1986. (Senate Hearing 99-252, Part II.)

The Gorbachev Program

Policies that Gorbachev has unveiled to date emphasize acceleration of economic growth through investment shifts, management and organizational reforms and programs to change the attitudes and work habits of the labor force.

Restructure Investment

- Increase expenditures on renovation of existing industrial plants from 1/3 to 1/2 of State productive investment during 1986-90.
- Increase investment in civilian machine building and energy by 80% and 35% respectively during 1986-90 over 1981-85 levels. Within machine building give special attention to high technology industries such as micro-electronics, computers and instrument making.
- Double retirement rates for equipment in industry during 1986-90; quicken the pace of commissionings, in part by reducing average construction times for new plants from 8 years to 3 1/2 years.

Increase Discipline

- Re-emphasize anti-corruption campaign initiated by Andropov.
- Institute anti-alcohol campaign to improve labor productivity and show resolve to squarely face difficult social problems.
- Better implement policies to reduce labor turnover and to increase worker effort by reducing absenteeism.

Change Personnel

- Achieve a working majority in the Politburo, a rapid pace of cadre renewal and the placement of key allies in important positions throughout the economic bureaucracy.
- Move some highly successful managers from the better performing defense industries into posts in the civilian economy critical to S&T performance.

Re-Organize Management

- Streamline management by forming coordinating bodies for groups of related industries, beginning with the agro-industrial, machine building, energy and construction sectors.
- Strengthen central planning while giving end-user enterprises more operational autonomy.
- Expand the industrial experiment that began in five industries in 1984 throughout industry in 1987. The experiment gives more autonomy to enterprises in day to day activities and marginally more control over investment decisions.
- Move enterprises to a system of self-financing where they pay a percentage of their profits to the state and finance their operations out of the remainder.
- Speed innovation by creating additional scientific-production associations (NPOs) that bring research, development and prototype production responsibilities together under one roof, and by forming inter-branch scientific-technical complexes (MNTKS) to coordinate research, development and production in technology fields that cut across ministry boundaries.
- Increase the supply of consumer goods and services by allowing some expansion of legal private activity.
- Ensure better product quality by placing state control officers empowered to reject inferior output in civilian industrial enterprises.
- Reorganize foreign trade to give some industrial ministries and enterprises more authority to conduct their own trade activities, and to allow foreign investment in Soviet industry.

Revamp Incentives

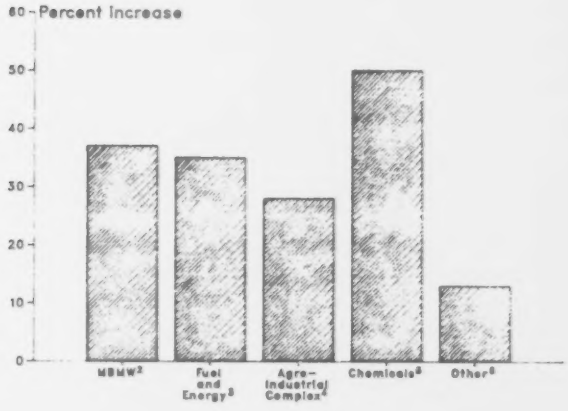
- Increase salaries and bonuses for scientific workers and engineers to encourage creation and use of new technologies.
- Differentiate wages to reward productive workers and penalize laggards.
- Implement price increases for "high" quality products and cuts for "lower" quality products.

Re-Educate The Public

- Begin computer literacy classes that will ease the task of using advanced equipment and provide training in "disciplined thinking."
- Set up regional technology centers, beginning with robotics.
- Implement management training programs that stress problem solving, simulation and game theory techniques relevant to the efficient use of new technologies.
- Change peoples expectations and attitudes by encouraging discussion of a wider range of economic and social issues.

Gorbachev's order to drastically increase investment in civilian machinebuilding is meant to improve the "staying power" of his program. But, while increased resources to this sector seem essential if Moscow is to come close to realizing its ambitious industrial modernization goals, the strategy risks an investment squeeze (see figure 4). The 12th Five-Year Plan has announced that energy investment will increase 35 percent during 1986–90. With investment in agriculture and its associated industries scheduled to continue to receive one-third of all investments, other critical sectors, notably metallurgy, construction materials, and transportation, may be shortchanged thus threatening production bottlenecks. If the consumer also gets short shrift in investment allocation—a likely development given tightening resource constraints—resulting consumer discontent could counter efforts to raise labor productivity.

Figure 4
USSR: Planned Investment Growth, 1986–90[1]



[1]Planned increase over 1981–85. Data for 1981–85 used in calculation are from Narodnoye Khozyaystvo SSR v 1985. Total investment planned for 1986–90 ––a 23.6 percent increase over 1981–85––is cited in Rzykhov report on the 12th Five–Year Plan published in Pravda on 19 June 1986.
[2]Estimate. Investment in civilian MBMW is scheduled to increase by 80 percent. In a June, 1985 speech Gorbachev said that about 5 percent of productive investment in 1981–85 was directed towards civilian MBMW implying 31 billion rubles went to civilian MBMW and 41 billion rubles to military machine building. MBMW investment estimated for 1986–90 assumes an 80 percent increase in civilian MBMW and a 10 percent increase in military MBMW–– equating to a 37 percent increase in total MBMW.
[3]According to Ryzhkov report on the plan published in Pravda, 19 June 1986, investment in the fuel and energy complex is to grow by 35 percent.
[4]According to Rzyhkov report cited above, investment in the Agro–Industrial complex (APK) will make up 1/3 of total investment. This equates to a 28 percent increase in APK investment over its 1981–85 level.
[5]According to Rzyhkov report cited above, investment in the chemical industry will increase by 50 percent.
[6]Other sectors include industrial materials, transportation and communications, light and food industries, domestic trade, consumer services, housing and construction.

VI. Roadblocks to Modernization

Ridding the economic program of inconsistencies and contradictions will not, by itself, spell smooth sailing for industrial modernization—the centerpiece of Gorbachev's strategy to revitalize the economy. Gorbachev's high expectations for MBMW raise doubt about the feasibility of his ambitious modernization goals. For his strategy to succeed, the civilian MBMW sector must be able to absorb a very large amount of investment—80 percent more investment is planned in 1986–90 than achieved in 1981–85—in a very short time. Moreover, it must change the structure, mix and quality of its output to a degree unparalleled in Post-World War II Soviet history. New machines must be tailored to meet the unique needs of plants being remodeled—a difficult task for an industry accustomed to manufacturing large lots of a small variety of equipment for use in plants being constructed under highly standardized designs. As recently as 1980 an authoritative Soviet journal reported there are practically no machine building enterprises where end-user plants can place orders for non-standardized equipment or technology.[9] Indeed, the unrealistic demands on Soviet machine builders may impel them to sacrifice innovation for cosmetic change and reproduce the same output mix that has prevailed for years—only faster and perhaps in a more slipshod manner.

There is some evidence that this is already happening. In 1986, eight of the eleven civilian machinebuilding ministries were criticized by the Central Statistical Administration (CSA) for not meeting delivery goals. Soviet government reports and high level officials, including Politburo member Zaykov, have indicated machine builders have not been meeting their targets for improving quality.[10] The apparent poor quality of machinery being produced limits the prospects for improving productivity in the receiving industries.

Moreover, the age and condition of plants in Soviet industry brings into question the feasibility of trying to modernize through renovation. Modern equipment requires facilities that have a broad assortment of heating and ventilation features. Most old buildings would have to be gutted or torn down and built again to accommodate such equipment. This is especially relevant to the thickly populated regions of the European U.S.S.R., the Urals, and the Donets and Dneper Basins—the old industrial core of the Russian empire which accounts for about 75 percent of industrial production.

Another obstacle to modernization through renovation is the poorly performing Soviet construction industry. Construction firms have always resisted doing renovation work because it is less profitable than new construction. Even if the incentive system were changed, construction enterprises would still be ill-equipped to carry out renovation work because they do not have sufficient quantities of needed equipment—a notable example is the shortage of mobile lifting and transport equipment that is necessary to rearrange existing industrial work space. The equipment they do

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[9] S.A. Kheinman, "Orghanizatsionno-strukturnye factory ekonomicheskogo rosta," *Ekonomika: organizatsiia promyshlennogo proizvodstva*, 1980, no. 6, pp. 56–82.

[10] See *Pravda*, 9 July 1986, p 2; and *Pravda* 9 August 1986, p. 2.

have is largely obsolete. The condition of the construction industry is even leading some Soviets to publicly question the feasibility of modernization goals. For example, the First Secretary of the Volgograd Obkom declared in his speech to the Party Congress on 28 February, 1986 that the projects planned for his oblast for the 12th-Five-Year period exceed the capabilities of local construction organizations to implement.[11]

With domestic industry strained toward its limits, Gorbachev will undoubtedly press Eastern Europe to provide more and better quality machinery and will probably look to the West for technology and equipment in selected sectors—for example energy, microelectronics and telecommunications—where no good supply alternative exists. Significant help from machinery imports, however, is in doubt:

—Moscow probably can not compel a significant increase in the supply of quality equipment from East Europe, since most CEMA countries are already economically hard-pressed and will need to maintain or increase their exports of machinery to the West to meet their international financial obligations.

—Lower hard currency earnings from oil exports are causing a decline in Moscow's hard currency import capacity. It is likely that during the 12th Five-Year period imports will fall by as much as one-third from their 1984 level.[12] This will force difficult decisions regarding the relative priority of machinery imports and food imports, and could slow the pace of industrial modernization.

—Chronic problems assimilating and diffusing foreign technology will continue to limit the benefits of the equipment the Soviets are able to import.

It is also doubtful that the S&T revolution which Gorbachev envisions will result in large quantities of high technology equipment coming off Soviet production lines in the 1990's. Creating and efficiently using new technologies is something the Soviet system has never done well and has become progressively less able to do as the economy has grown in size and complexity. Today, the development of sophisticated automated technologies is a rapidly changing and high risk business: the pace of improvements in high technology products and production processes in the West is increasing rapidly, owing largely to the free flow of information and competitive pressures in Western market economies. In the Soviet economy, where performance is judged by achievement of centrally imposed short-term output goals, the rapid creation and widespread assimilation of sophisticated technologies—let alone product improvements—may be incompatible with any system of management and rewards that the Gorbachev regime is willing and politically able to implement. The relative successes of the Soviet defense industries in the past have resulted primarily from their priority access to scarce high-quality resources and the willingness of the regime

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[11] Speech by V.I. Kalishnikov, First Secretary of Volgograd CPSU Obkom, at 28 February 1986 morning session of 27th CPSU Congress. Published in 2 March 1986 *Pravda*, p. 3.

[12] See Joan McIntyre, "The U.S.S.R.'s Trade and Payments Position," in this compendium.

to ignore the high cost of success—a condition that can not be applied economy-wide.

VII. Prospects

Gorbachev realizes that turning the economy around is a difficult and long range task. Over the next few years, vigorous leadership and mobilization of effort should provide enough increased output to allow him to claim that things are gradually getting better, even if the industrial modernization campaign gets off to a slow start or falters. And with the luck of better weather, agriculture could improve enough for Gorbachev to actually achieve his very ambitious growth goals for a year or two. Conversely, continuing bureaucratic resistance and a couple of years bad luck with the weather could make achieving these goals difficult.

The key to Gorbachev's ultimate success or failure, however, is industrial modernization. Unless his modernization strategy takes hold, and substantial quantities of new, better and more sophisticated equipment are produced and assimilated, the gap between Western and Soviet technology is likely to widen, bringing increased risk to the General Secretary's power and authority, especially as the military leadership grows increasingly impatient with the lack of progress and the lack of an increased resource commitment.

Gorbachev undoubtedly hopes to have a comprehensive and detailed game plan in place to be implemented during the 13th and 14th Five Year Plan Periods (1991–2000). In the meantime, he will probably continue to improvise and keep his policy options open. Recently, for example, he has sanctioned debate about the use of more flexible pricing and the role of bankruptcy and unemployment in a socialist economy, while at the same time warning East European economies not to succumb to the glitter of market oriented reforms. This strategy seems pragmatic. He is developing policies to help the existing system meet what he sees as its potential, while keeping the door open to the possibility of systemic reform should he view it as necessary and feasible in the future.

ORGANIZATIONAL RESTRUCTURING OF THE SOVIET ECONOMY

By Joseph S. Berliner*

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I. Summary

The promotion of technological progress is central to Gorbachev's goal of "accelerating the social-economic development" of the country. Like his predecessors he criticizes the technical and managerial personnel for the inadequate technological attainment of the nation, but unlike them, he lays much of the blame on the economic mechanism as well. He has therefore called for a radical "restructuring" of the entire economy and society. This paper deals with one part of his extensive program, the organizational restructuring of the state sector and the private sector of the economy.

In the reorganization of the state sector the redistribution of authority between senior and junior organizations is to be governed by the principle that the senior organization should concentrate on long-term strategic planning, while the junior organization should be free to operate independently in its realm of responsibility. The principle is designed to guide the restructured relationships between Center and Ministry, and between Ministry and Enterprise. In both cases the senior must avoid the "petty tutelage" of the junior. While Gorbachev brings to the task more energy and determination than his predecessors, there are no compelling reasons to expect that the forces that have frustrated similar efforts in the past will not do so again.

The encouragement given to the private sector, however, goes well beyond what had been tried in the past. Although it will continue to be limited in scope, compared to some other socialist countries, it may be expected to provide a significant benefit to the

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economy, particularly to consumer welfare. Gorbachev's statements, however, contain elements that might one day serve as the basis of a new three-sector model of a Soviet economy in which the private sector (along with the state and household sectors) plays a major, though not a dominating, role. Those elements are the free sale of overplan output by state enterprises, the stability of normatives, and the expansion of voluntary cooperatives. There is no basis at present for forecasting that Gorbachev intends to take the risk of moving in that liberalizing direction, but if he should do so, the three-sector model is the most probable direction of change.

II. Introduction

The goal that General Secretary Gorbachev has set for his administration is the "acceleration of social-economic development." To propel the nation toward that goal he has called for a "radical restructuring" of the entire society and has invited public criticism of the institutions and practices of the past. Extensive personnel changes have been made and the structure of investment has been greatly altered. New organs of economic administration have been founded, old organs have been combined or eliminated, and whole sectors such as agriculture, construction, light industry and foreign trade have been reorganized. The distinction between legal and illegal private economic enterprise has been made more precise with the intention of encouraging the former and discouraging the latter. Many more measures are waiting in the wings, including new statutes governing the operation of the enterprise, the system of price formation, and the organization of wholesale trade.

After the 27th Party Congress many observers abroad remarked on the contrast between the boldness of the new government's rhetoric and the timidity of its actions. Others urged a wait-and-see stance, arguing that the General Secretary needed more time to consolidate his political position before he could undertake a course of action consistent with his words. From the perspective of the year's end it now appears that the latter were closer to the mark. There is now good reason to expect that when Gorbachev finally gets all his ducks lined up, the economy and society will have been restructured to a degree unparalleled since 1957 when Khrushchev abolished the ministries entirely and replaced them with territorial economic councils.

The question that will eventually have to be answered is to what degree will Gorbachev's restructuring have succeeded in attaining his objective of accelerating the rate of economic growth. Perhaps an answer to that question will be offered in the next Joint Economic Committee volume three years from now, when the full program will have been in operation for some time. Even a full-dress review of the actions that have been taken so far will soon be out of date, with so many major measures still to be published. The more modest purpose of this paper is to offer a few observations on some aspects of the program as it has unfolded thus far and on the directions that it might take in the future.

III. The Centrality of Technological Progress

It is not just any kind of economic growth that Gorbachev wishes to accelerate but growth of a particular kind; namely, growth based on the "intensification of production on the basis of scientific-technical progress." [1] His conception of the nature of the problem of promoting technological progress in the USSR, as presented in his account of the Briansk Machinebuilding Plant, is the conventional one. The reconstruction and reequipment of that enterprise is now half completed, and it has been disclosed that the newly installed equipment is already partly obsolete. But most of all, the new locomotive that the plant is designed to produce eventually is also obsolete; a more efficient model has already been designed and tested. "Unfortunately," he remarks, "many scientific discoveries and important inventions lie around for years, and sometimes decades, without being introduced into practical application."

That is a longstanding theme in the literature. How longstanding it is can be seen from the following report to a preceding Party meeting:

> Many leaders of industrial and transportation enterprises undervalue the importance of new technology; they don't work at improving it further or at mastering the production of new machines, materials and products. Highly valuable inventions and product improvements often lie around for years in the scientific research institutes, laboratories and enterprises, and are not introduced into production.

The date was February 15, 1941.[2] The occasion was the report by Georgii Malenkov to the 18th Party Conference, the last general Party meeting before the Nazi invasion, forty-six years ago.

It is evident that the Party leadership's conception of the nature of the problem has not greatly changed. The continuity of both the problem and the perception of it over so long a period is cogent evidence that the source of it is deeply rooted in the structure of the economic system.

What one does about a problem depends on what one regards as the cause. Gorbachev expresses his view as follows: "The basis of these attitudes to new things is often the ambitions of some groups of scientists; a bureaucratic hostility to 'foreign' (*chuzhim*) inventions, and the lack of interest by producers in implementing them." That view of the cause also has a long history; Malenkov criticized the "conservatism" of managers and called for an end to "tail-dragging (*khvostistskomu*), which is essentially an opportunistic attitude toward new technology." The two officials are correct to note that such conservative attitudes are to be found in Soviet institutes and enterprises, but that does not signify that that is the source of the problem. For if it were, one would expect such attitudes to be absent, or at least less salient, in economic structures that are highly innovative, such as the advanced capitalist economies. However, the western literature on innovation also regards managerial conservatism in capitalist countries as a major obstacle to technological progress. One hears about the problem of the "NIH syndrome," where the term means "Not Invented Here," rather like Gorbachev's *chuzhim* inventions. Hence Soviet personnel are not

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[1] Report to the 27th Party Congress, *Ekonomicheskaia gazeta*, No. 10, March 1986. All quoted statements by Gorbachev not otherwise footnoted are from the Report.

[2] *Izvestiia*, February 16, 1941.

distinctive in their conservatism; that is not the heart of the Soviet problem. Such conservatism is very likely the normal property of large organizations everywhere. What distinguishes the more innovative from the less innovative structures is the set of forces that act to overcome such conservatism, forces that include strong positive incentives for innovation and negative sanctions for the non-innovative organization.

The implication of the foregoing is that Gorbachev continues the long line of Soviet political economics that blames the managers for the deficiencies of the system. It also raises doubts about the benefit to be gained from wholesale changes of personnel; if it is a systemic rather than a psychological matter, the new people are likely to make the same kinds of decisions as their predecessors had learned to make.

However, while Gorbachev continues the tradition of blaming the personal qualities of managers, he departs from the tradition by asserting that the structure of the system itself is also to blame. More than any preceding Party leader except perhaps Andropov, Gorbachev calls attention to the need for profound changes in the economy. Not only does he reintroduce the term "reform" but he equates "the word restructuring with . . . a genuine revolution in the entire system of relations in society, in the minds and hearts of people." [3]

The General Secretary has come a long way from the Stavropol Obkom Secretary called up to Moscow a few years ago. The call came not because he was known then as a radical reformer. He must have been known rather as a man who could knock heads together and get things done. It is difficult to imagine that a man could have risen so high in the Party bureaucracy, and in the process survived so many *nomenklatura* reviews of his ideological convictions, while remaining a closet radical in his deepest convictions. The realization that radical reform was required must have come to Gorbachev from his recent experience in the Center, and from exposure to the ideas of people like Zaslavskaia and Aganbegian. I suspect that beneath it all, however, he still thinks, with Malenkov and all politicians who have to deal with economics, that the basic problem is with people. If people only had the right attitudes, the system would work quite well. He turns to a revolutionary restructuring of institutions not with enthusiasm but with resignation, because the people are inadequate to the perfectly good old system. If this is a correct interpretation of Gorbachev's disposition, the restructuring in its final form may turn out not to be that radical after all.

IV. The State Sector

The formula for the organizational restructuring of the state sector is "the union of centralism and the independence of economic organizations." [4] That formulation has a long history in Soviet discussions of economic reform, and the reaffirmation of the commitment to centralism makes it clear that it is within-system

[3] Khabarovsk speech, *Pravda*, August 2, 1986.
[4] Report to the 27th Party Congress, *Ekonomicheskaia gazeta*, No. 10, March 1986.

changes that are intended. In the manner of past reforms, the purpose is to improve the operation of the central planning mechanism and not to dismember it.

The emerging pattern of restructuring involves two sets of organizational relationships; center-ministry and ministry-enterprise.

CENTER-MINISTRY

Central control is being strengthened in some respects and reduced in others. It has been strengthened first by the establishment of new Central organizations like the State Committees on the Agro-Industrial Complex and on the Computer Industry, and new Bureaus of the Council of Ministers like those on Social Development and on the Machinebuilding Industry. It is to be strengthened, secondly, by concentrating Central effort on (1) the coordination of activities that cut across ministry boundaries, and (2) major issues of general policy. Gosplan, for example, is to be released from work on current economic questions and to serve instead as a "general staff of the economy" dealing only with long-run planning problems and major allocational issues.

Central control is to be reduced, on the other hand, by "putting an end to the practice of interference by the Center in the operational activity of lower-level economic units." This presumably means that the Central bodies must refrain from interfering in decisions that are properly the responsibility of the ministries and for which the ministries are to be held accountable. The Politburo, for example, should no longer occupy its time with such detailed operational questions as whether trucks should be used in bringing in the harvest in Kazakhstan.[5]

These measures have been interpreted by some western analysts to signify an increase in centralization, at the expense of the ministry. As I see it, the measures are better viewed as a redistribution of functions between Center and ministry, the Center exercising more authority over major policy matters, but the ministry now given more authority than it had before on matters internal to its own operation.

These measures are consistent with general principles of good administrative practice in hierarchical organizations. If they are implemented they should improve central management to some degree.[6] There is reason to question, however, whether the Center will indeed voluntarily transfer significant decision-making power from itself to the ministries.

CENTRALIZATION OF POLICY DECISIONS

There is a certain asymmetry in the way analysts (both Soviet and western) evaluate changes in the economic mechanism on the

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[5] See any recent report in *Pravda* of the Politburo agenda for evidence of the detailed involvement of the Politburo in minutiae of the economy.

[6] If the Center does in fact continue its 'petty tutelage" over the ministry while compelling the ministry to reduce its detailed control over enterprises, the resulting redistribution of authority may be described as a "squeezed baloon." Power is transferred both upward to the Center and downward to the enterprise. A change of that kind could properly be described as "increasing both centralism and the independence of enterprises," a concept that some observers regard as self-contradictory. It is self-contradictory only if one has a two-level hierarchy in mind.

one hand and changes in policy decisions on the other. With respect to the organizational matters that are the subject of this paper we do not strive to evaluate actual decisions but rather the way in which they are made; is a particular class of decisions (e.g. local substitutions among inputs) best made at the central level, or at the ministry or enterprise level? In the case of policy decisions, however, we tend to evaluate the policies themselves—is it wise to double the volume of investment in machinebuilding in the 12th Plan?—and give no attention to the way in which the policies are decided upon. However, excessive centralization of policy decisions, like excessive centralization in the economic mechanism, can greatly decrease the efficiency of the system.

Consider Gorbachev's decision to increase the proportion of new investment to be directed toward the renovation of existing enterprises rather than to the construction of new enterprises. Some very smart economists have urged this policy and they are very likely right; on balance the economy may be better off with the new policy. The question I wish to raise is whether a policy decision of this kind is the best way for an economic system to do business.

One way in which a centrally planned economy might manage the process of capital expansion would be by means of a general Rule of Calculation. The Rule would be used, for example, in deciding whether a five percent increase in aluminum production is most efficiently secured by the renovation of existing plant and equipment or by the construction of a new enterprise. The Rule would require many factors to be taken into account, such as the rate of technical advance in the industry, the age structure of the existing capital stock, the forecast of future technical advance, and so forth. The Rule would be sufficiently general to be applicable to all decisions in all industries and enterprises, but the answer is likely to differ from case to case. In industries that anticipate rapid technical advance the Rule is likely to favor replacement of the older equipment, other things equal; but where technology has stabilized, the Rule might favor the construction of a new plant. The value of the Rule is that the decision in each case takes acccunt of the special conditions of that case.

Gorbachev has not employed this approach. Having been persuaded that excessive new construction had been undertaken under Brezhnev, his Party has now changed the policy to a concentration on renovation. That approach is in the tradition of that unfortunate feature of Soviet political economics known as the "campaign." Campaigns originate in the decision that a certain new policy or organizational form has proven to be successful. It is then decreed as national policy and officials throughout the country take the cue and proceed to implement the idea wherever possible, often without regard to local conditions. If the past is a guide to the future of this new campaign, one may predict that within a few years reports will begin to appear that in a particular enterprise perfectly good equipment had been scrapped and replaced at high cost by new equipment that was barely more productive. Then more articles on the same theme will appear. If Gorbachev is still General Secretary at that time, the campaign may be quietly

dropped. If he is not, it will be regarded as having been a harebrained scheme.

To generalize on the matter, the quality of a productive economy depends on its ability to make fine distinctions. The replacement of a metal part costing $.20 by a plastic part costing $.10 does not seem like very much. But if every production unit is motivated to make such fine distinctions with respect to every part, that economy will outperform one which decrees that all parts must be metal or plastic. Moreover, such decisions are best made locally, by those who know the specific conditions of their own enterprises, their own customers, and their own work force. Some considerable part of the difference in factor productivity between the USSR and the West may be due to the greater ability of the latter to discriminate more finely in terms of local knowledge, in the manner of a Hayekian entrepreneur.

Gorbachev intends to increase the independence of lower-level organizational units and in that sense he must regard himself as something of a decentralizer. He is probably not aware that while he promotes decentralization in matters relating to the economic mechanism, his investment policies like the renovation campaign involve highly centralized decisions. As Marx warned the bourgeoisie: *"de te fabula narratur!"*

When a political system is highly centralized, it is so natural for the leadership to centralize economic decisions that the question of the efficiency of that use of power is probably not often raised. That relationship between political and economic power does not augur well for the future of the measures of decentralization in the economic mechanism.

MINISTRY-ENTERPRISE

Ministry-Enterprise relations are to be changed in the same way as Center-Ministry relations; the ministry's performance is to be strengthened by the concentration of its efforts on matters of ministry-wide policy like the direction of technical change and the coordination of activities within the branch; but the ministry's power vis-a-vis the enterprise is to be reduced by the cessation of its involvement in the enterprise's internal activities.[7]

A number of devices are to be employed to expand the enterprise's independence. First, the performance indicators for which it can be held accountable to the ministry are to to be greatly reduced in number and are to be confined to indicators that measure "end results" only. The decree on light industry, for example, specifies that profit, as "the most important generalizing index," is to serve as the basis of enterprise accountability.[8] Profit is evidently regarded in this industry as the best measure of "end results." Only two other indicators of enterprise performance are to be confirmed by the higher authorities.

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[7] This requirement is conveyed in surprising language; the ministry must cease exercizing "petty tutelage" over the enterprise. The resurrection of that slogan of the failed Brezhnev-Kosygin reform of 1965 does not appear to be the most felicitous way to whip up enthusiasm for this new venture in reform.

[8] *Pravda*, May 6, 1986.

A second device is an increase in enterprise financial autonomy, or "self-financing." The purpose of this device is to end the practice of "income levelling," or the transfer by the ministry of the profit earned by the more profitable enterprises to the enterprises that were suffering losses. As practiced in the widely publicized experiment in the Frunze Production Association in Sumy, it means that the enterprise is permitted to retain sufficient of its profits to finance not only all its costs of production but also its own investment. The Association pays a profit tax (30 percent of its profit last year) and the remainder is left at its disposal, to be used at its own discretion.[9]

A third device is the general use of normatives rather than directives as instruments of ministry control over the enterprise. For example, when a ministry controls wage expenditures by a directive, it says to the enterprise: given your output plan, you may spend 1 million rubles on wages. When it controls wages by a normative, it says; you may spend 20 rubles in wages for every 100 rubles of output. Directive control is more centralized; if the enterprise intends to overfulfill its output plan, it must first apply for authorization to overspend its wage limit. Under normative control it can spend however much it needs to, without requiring authorization, as long as it stays within its normative of 20 rubles per 100 rubles of output. Thus control by normatives does transfer a certain degree of authority from ministry to enterprise.[10]

Normatives may be used to control individual cost items like wages, fuels, major raw materials, and so forth. They have also been used to regulate deposits into enterprise material incentive funds. A normative of the latter type might specify, for example, that for each 100 rubles of profit 6 rubles may be deposited in that fund, to be used for the payment of bonuses.

The autonomy that a normative confers on the enterprise would be eroded if the ministry retained the power to tighten it whenever an enterprise's exceptional performance produced earnings or profits far in excess of what was expected when the normative was established. The tightening of normatives in such cases has been the usual practice in the past, and has produced the usual response to the "ratchet" principle: enterprise management withheld effort in order to avoid a tightening of the normative.

To eliminate that incentive-eroding practice, the government has declared that hereafter normatives are to be "stable," meaning that once established they are to remain in force for a specified period of time. Normally they are to be established at the beginning of a five year plan and are not to be changed by the ministry for the duration of the five year period. The principle of stable normatives has been incorporated in the wage reform that is to take effect in 1987. The regulations provide that there must be no limits on the wages that a worker may earn; if he doubles his productivity he will double his earnings. The work norms are presumably to be set at the beginning of the five year plan and may be changed

[9] *Literaturnaia gazeta*, November 6, 1985.

[10] The decision to renovate equipment rather than construct new enterprises is a directive. A Rule of Calculation like that proposed above is rather like a normative in the sense that it gives lower decisionmaking units greater scope for choices made in full knowledge of local conditions.

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not more than once during the plan period. Similarly the wage fund for specialists is to be determined by normatives, and the ministry is expressly forbidden from interfering in the restructuring of the wage system by the enterprises.[11]

Efforts to maintain stable normatives have been made in the past, most notably in the July 1979 planning reform. Evidently they have never been made to stick; eventually the enterprise that had tightened up on its labor costs found that its normative was reduced and its revealed performance became its new target. Often the agent of norm revision was the Ministry of Finance, which seems to regard any unusually large income as probably "unearned." Sometimes the agent was the enterprise's own ministry which, hardpressed to provide financial resources for some of its enterprises, extracted them from other enterprises that had revealed their ability to produce with fewer resources. These past sources of the erosion of stable normatives, however, are the kind that a powerful and determined General Secretary could eliminate, or at least contain, if he is prepared to bear the onus of defending the widening income inequality that would follow from his strategy.

ASSESSMENTS

The western observer is inclined to regard these measures of organizational restructuring as likely to contribute toward the goal of improving economic performance. The curtailment of bureaucratic interference in an enterprise's activity certainly sounds like a commendable objective. That inclination, however, derives from the experience of enterprises operating in a reasonably well-functioning market economy. It is not at all evident that in an economy in which market pricing and competition are not present, decentralization is generally a good thing.

For example, if prices cannot be trusted to reflect relative costs reasonably well, an increased reliance on profit as a measure of "end results" may not improve matters, or may even make them worse; one might be better off if a ministry were looking closely over the enterprise's shoulder in that case. Similarly, the logic of self-financing depends on the assumption that the enterprise that earns more profit must be better managed than the one that suffers a loss. That assumption may not be valid if prices are irrational; a different set of prices might convert profits into losses and losses into profits. Much will therefore depend on the forthcoming reform in the method of price formation. That reform will have to be far more radical than anything that has been attempted in the past for prices to be able to support reasonably efficient decentralized allocation choices.

A broad shift from directive control to normative control does indeed constitute genuine decentralization, and a corresponding diminution of the degree of detail in ministry control over enterprises. However, normatives as applied to inputs imply fixed proportions, and may therefore lead to non-optimal choices in instances where inputs are substitutable. The problem is compounded

[11] *Pravda*, September 26, 1986.

by the decision to keep normatives stable for a lengthy period of time during which technology and costs may change.

It is therefore difficult to foretell whether the organizational restructuring will promote the objective of accelerating economic growth.[12] Nor is it yet certain that the restructuring program will be fully implemented and will endure. The experience of past efforts at reform suggests that implementation will be difficult. On the Center-Ministry level, State organizations, having their own responsibilities and sources of information, have found it difficult in the past not to interfere in ministry decisions that are erroneous in their judgment. On the other hand the ministries, often lacking resources, uncertain about the relative priority of alternative choices, or embroiled in controversy with other ministries, have found it difficult not to apply to the State organization (particularly Gosplan) for assistance or resolution. Similarly, on the Ministry-Enterprise level, efforts to restrain ministries from excessive interference in enterprise affairs have foundered, most notably in the 1965 Reform. The published literature is not rich in analyses of such past efforts at reform, which does not inspire confidence that the reasons for past failures have been thought through and faced up to in this new round.

V. The Private Sector

The General Secretary's report to the 27th Congress contained a number of remarks that reflected a positive disposition toward the expansion of private economic activity. To be sure he left no doubt about his determination to combat activities that produced illegal or unearned income, but that was to be distinguished from lawful private activity.

The prospects for the private sector appeared to dim, however, with the publication on May 28th of the decree on unearned income.[13] The decree was so threatening to private sector producers, both legal and illegal, that the supply of foodstuffs on the collective farm markets visibly decreased during the summer.[14] Then on November 21 the government published the law on private economic activity.[15] Perhaps one of the functions of that law was to undo some of the damage done to legal private activity by the earlier decree, but it went rather further than that. It may be interpreted as an invitation to any Soviet citizen to engage in private economic activity within the limits specified in the decree.

The limits are important. It may be a full-time activity only for persons who might not normally hold a state sector job, such as housewives and pensioners; others may participate only in their free time.[16] Only family members may participate; the hiring of

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[12] The measures of general restructuring discussed here seem to be directed more to the improvement of static efficiency than to the acceleration of the rate of technological progress. An increase in static efficiency over a number of years, however, would show up in an increase in the growth rate of aggregate factor productivity, and therefore in the rate growth.

[13] *Pravda*, May 28, 1986

[14] *Pravda*, July 14, 1986

[15] *Izvestiia*, November 21, 1986

[16] One clause provides, however, that under specified conditions "other citizens who are not employed in social production" may engage full-time in private activity. That provision may have been included in anticipation of an increase in temporary unemployment. In China one of the stated purposes of the legalization of private activity is to provide a means of earning a living for people unable to find state-sector jobs.

someone else's labor is forbidden. These limits ensure that the extent of private activity will be quite restricted, at least initially; compared, for example, to such countries as Hungary and China.[17]

Nevertheless the decree provides sufficient encouragement that one may expect a considerable expansion of the private sector. It authorizes private production of consumer items like furniture, rugs, and clothing; consumer services like hairdressing, taxi transport and tourist accommodations; repair and servicing of automobiles, appliances and residential facilities; small-scale construction services; and various tutoring, teaching, translation, and medical services. A permit is required, financial accounts must be kept, and income taxes are to be paid on the earnings. State organizations are encouraged to rent space and equipment to private sector producers for these activities. The materials required for private production may be purchased in the state (or cooperative) retail stores, or in the collective farm market, or in the local depots of the State Committee on Supply (Gossnab.) The law does not specify the ways in which the goods and services may be sold, but they are presumably to be sold directly to customers, or on the collective farm markets, or to the state and cooperative trade organizations for subsequent sale to the population. The prices presumably are to be free and unregulated. What is expressly forbidden, by the earlier decree on unearned income, is middleman trade—the purchase of goods produced by others for sale at a higher price.

Most of the specified activities were not illegal in the past, but they were frowned upon by the authorities, in part because the legal was often mixed with the illegal; the moonlighting plumber legally replaced the leaking faucet with one that had been stolen from the plant. The principal effect of the new law is to bring these activities out of the shadows by declaring them to be socially beneficial and to be supported and encouraged by public organizations. The volume of private activity is therefore likely to increase.

The private sector, in which we may include the agricultural private plot as well as the private economic activity addressed by the new law, has a clear place in Gorbachev's conception of the restructured Soviet economy. If it should be judged successful, moreover, there are several instruments at hand by means of which its scope can be greatly expanded.

1. In a brief passage in his report to the 27th Congress Gorbachev recommended that enterprises be given the right to sell overplan production independently, to whomever they wish, presumably at whatever prices they can command. He suggested that that right might also be extended to the resale of unused materials and equipment. "It makes no sense to destroy or scrap anything that can be used by families, or in housing construction or garden cottages," he stated. To my knowledge that proposal, as applied to non-farm enterprises, is entirely new.[18] The thrust of his recom-

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[17] Citizens are encouraged to form cooperatives, however, which could greatly extend the limits, as discussed below.

[18] Contrast this to the "classical" view of Malenkov on the same theme: "It must be stated forthrightly, Comrades, that the practice of selling so-called 'removed from service' machinery, and unused materials and equipment, amounts to no less than the plundering of socialist property." *Izvestiia*, February 16, 1941.

mendation of a *prodnalog* is to extend the same right to farms; they too should be given the right to sell freely any output in excess of their plan targets.

2. In the past the effect of the "ratchet" principle of planning has been to discourage overplan production. Gorbachev's espousal of stable normatives, however, is intended to eliminate the effort-depressing effect of the ratchet. If normatives are in fact kept stable, even for the limited period of a five year plan, the volume of overplan production might rise considerably during that period. Enterprises would have a strong incentive both to fulfill their plan targets and to maximize the volume of overplan production. The planners would have a powerful instrument for influencing the volume of overplan production by varying the tautness of the normatives. A reduction of plan target tautness could raise both the total value of production and the ratio of overplan to planned production.

3. At a number of points in his report Gorbachev alluded to the benefits to be derived from the expansion of cooperative production. Cooperatives, he stated, have not at all exhausted their possibilities for socialist production. They should find wide application in such activities as housing construction, the production of goods, food gardening and household services, and trade. In a similar vein he recommended the expansion of contractual relations between the collective farm and such subordinate units as the brigade, the link and the family; the latter, indeed, should be provided by the collective farm with equipment and even land for work to be done under contract. He followed this recommendation with a criticism of the prejudice against "commodity-money relations," which is the Soviet Marxian expression for nonstate economic activity.

All three of these notions have since been incorporated in the legislation published since the Congress. The sale of overplan production is provided for in the agricultural reorganization decree [19] and in the light industry decree.[20] The stability of normatives, as noted above, has been incorporated in the wage reform. And the law on private economic activity "encourages . . . the association of citizens in cooperatives, voluntary organizations and friendly societies" for the purpose of conducting private economic activity under the conditions specified in the law.

A THREE-SECTOR MODEL

When the private sector expands to the limits permitted under the present legislation, the government will have to decide whether those limits are optimal, or whether they should be contracted or expanded. If they decide to expand it substantially, one may envision a future Soviet economy sufficiently distinctive to warrant classification as a new model of a socialist economy, that may be called a "Three-Sector Model." In addition to the traditional state sector (including the collective farm) and the household sector, there would be a substantial private sector the size of which would be regulated by the State. The private sector would consist of a va-

[19] *Izvestiia*, March 29, 1986.
[20] *Pravda*, May 6, 1986.

riety of production units, ranging from individuals to large voluntary cooperatives. Planned production would flow among the enterprises of the state sector as before, directed by the traditional method of material-technical-supply; and it would also flow between state sector enterprises and households as before. Overplan production, however, would now flow from the state sector (1) to other enterprises in the state sector but outside of the state supply channels, (2) to the household sector for consumption, and (3) to the private sector for future production of goods and services. The output of the private sector would flow, in turn, to households, to state sector enterprises, and to other private sector units. The output of the private sector might include, in addition to that now authorized, catering services for the population, specialized high-quality components and high-tech consulting services for the state sector, and other goods and services for which it would prove to have a comparative advantage such as quick turnaround time, flexibility, and quality.

The three-sector model would have a number of advantages:

1. It would divert into legal productive activity much of the entrepreneurial effort presently confined to the illegal portions of the second economy. It is understood that much cooperative production would differ little from small-scale private enterprise, but it would operate under state regulation. Cooperation is an ideologically acceptable and legal way of expanding the scale of private enterprise without violating the prohibition on the hiring of other people's labor.

2. It could reduce the degree of supply uncertainty in the state sector by providing a new flexible source of supply for a variety of inputs not easily or quickly secured through the traditional state supply system.

3. It would significantly increase the supply of consumer goods and services to households. If the welfare-value of wider choice, higher quality and reduction of queuing time could be measured, the measured contribution of the private sector to consumer welfare would greatly exceed the measure of its ruble value.

4. The government would have a variety of instruments for controlling the size of the private sector; for example, by changing the regulations governing cooperatives, and by varying the tautness of state sector plans, which determines the volume of overplan output flowing to the private sector. Unlike an "all or nothing" reform, the three-sector model is finely divisible. The private sector can be easily expanded to any desired size if it successful. If it gets out of hand it can be cut back, in principle, to any desired size, even back to the traditional two-sector model in the extreme. The form of the private sector can also be varied regionally, by creating limited "free enterprise zones" in Siberia and the Far East, for example.

5. The prices that emerge in the transactions of the private sector may increase the pressure on the state sector to bring state prices into closer alignment with market clearing prices. It also provides an inflation-combatting opportunity for the state sector to raise its prices on part of its output by competing with the private sector; in the collective farm market, for example.

6. Finally, it would be a uniquely Soviet model. It does not require the abandonment of traditional directive planning and the

material supply system as in Hungary; within the dominant state sector life goes on as before under the classical mechanism of central planning. It does not substitute self-management for state ownership as in Yugoslavia, and it does not permit the virtually unregulated expansion of private enterprise as appears to be the case in China. It can be represented as a distinctively Soviet model of economic organization under mature socialism. It can claim some of the glory of Lenin and the NEP, dialectically emerging on a new and higher plane appropriate to the stage of the scientific-technical revolution. In the earlier stage of the NEP the private sector dominated the smaller "commanding heights" of the state sector; in the modern three-sector economy the state sector overwhelmingly dominates the private.

The disadvantages are sufficiently evident that they needn't be spelled out. There will be some diversion of resources into the private sector contrary to the government's priorities. The possibility that the private sector will develop political power outside of Party control cannot be discounted. Income distribution will change in ways that will be ideologically repugnant and politically problematic. There will be a great deal of corruption and illegal activity, but it should not yet be conceded that it would be greater than at present; it may be argued to the contrary, that the increased satisfaction of consumer (and industrial) demand will reduce the opportunity for corrupt state officials to receive bribes for the goods and services over which they have control.

It is not enough, however, for critics at home and abroad to demonstrate that the new "plan-and-market" model will contain many forms of inefficiency, some new and some old. Any graduate student could easily show that. The question is rather whether the new model will be less or more efficient than the preceding economic arrangements, and that would be much harder to determine. There is no end of models that would perform better than the classical system, but the three-sector model is the only one that the present government is likely to entertain.

It is possible that Gorbachev's restructuring will not proceed further toward the three-sector model. For a few years at least it would be prudent for the government to await the results of the restructuring of the state sector and other new policies before considering major new directions of change. Unless the growth rate falls well below the rates of recent years there may well be no major new changes at all. If further changes do occur, however, and if they are in a liberalizing direction rather than a return to a tighter neo-Stalinist economy,[21] something like the three-sector model is the direction in which Gorbachev seems inclined to move.

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[21] The conditions under which various types of change are likely to be introduced are discussed in Joseph S. Berliner, "Planning and Management," in Abram Bergson and Herbert S. Levine (eds.), *The Soviety Economy: Toward The Year 2000* (London: Allen & Unwin, 1983) pp. 350–390.

THE SOVIET BLOC IN THE WORLD ECONOMY

By Lawrence R. Klein and Daniel L. Bond*

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Summary

A number of recent developments provide the basis for some optimism about the prospects for the world economy over the next few years. Energy prices have fallen, the U.S. dollar is depreciating gradually, interest rates are down, and inflation has been brought under control. Although these changes have brought distress to some countries and sectors, they provide the basis for a continued recovery of the world economy from the recession of the early 1980s.

The Soviet bloc countries share with the rest of the world the costs and benefits of these changes. The drop in energy prices will hamper Soviet trade with the rest of the world, and could pose temporary problems for Eastern Europe as well. But the general revival of world trade should allow for growth of non-fuel exports, and lower interest rates will ease the debt-servicing burdens of the region.

Over the longer term the position of the Soviet bloc in the world economy will depend on the success of the region's effort to accelerate techological progress.

Recent Developments in the World Economy

A number of exceptionally positive changes in the world economic environment have transpired recently. Energy prices are again following the laws of supply and demand, which are more understandable than the somewhat arbitrary decisions of OPEC. The U.S. dollar has depreciated from its unusually high value in early 1985. Interest rates have been falling in many countries and inflation has been brought under control in most, if not all, parts of the world. None of these momentous economic events is an unqualified

* An earlier version of this paper was presented at a Workshop on East-West European Economic Interaction held in Florence, Italy, September 1986. The authors are with the University of Pennsylvania and Wharton Econometric Forecasting Associates, respectively.

positive factor in the outlook, but in every case the good outweighs the bad side in affecting world averages.

Obviously some countries or regions which are important oil producers and exporters are experiencing a setback because of low oil prices, but if we concluded that the world economy suffered a significant setback in 1973–75 and 1979–80 when oil prices rose so markedly, then it is reasonable to conclude now that the world, as a whole, will benefit when prices come down. The reasoning is not completely symmetric, however, because some major exporters are now heavily burdened with international debt and were not in corresponding situations in 1973, when the change in energy terms of trade began to take place. Apart from the altered conditions for such countries as Mexico, Venezuela, Nigeria and Indonesia, the gains for energy consumers all over the world outweigh the losses for producers. It is also notable that the tendency towards lower inflation rates that began in 1981 coincided with a leveling off of oil prices and was helped by their decline in later years.

Economists have had difficulty in predicting the course of exchange rates, after the abandonment of fixed parities in 1969. The ascendancy of the U.S. dollar after 1980 was puzzling, not in its initial phase, which was a natural reaction to the return of America's current account to balance, but in its magnitude and prolongation after 1983. Economic analysis indicated that the dollar would eventually have to depreciate, but the timing posed a problem. After a sharp speculative run-up in early 1985, the dollar finally did recede. Its fall has been monitored and urged along by the joint actions of the finance ministers of major industrial nations who met in New York on September 22, 1985. The dollar is expected to decline still more during the next few years. It is not that the decline does so much all by itself for the good of the world econmy, but a gradual and steady decline that is accompained by falling interest rates can be quite beneficial. This is the scenario of the "soft landing", and its contribution to world economic performance is to increase world real growth and trade, and reduce inflation.

The opposite to the "soft landing" case is the "crash landing" case in which there would be a capital flight from the United States and probably a rise in interest rates in order to attract capital for the financing of the American fiscal deficit. Such capital flight could be caused by a loss of confidence on the part of foreign investors in the quality of dollar-denominated financial assets. The crash landing scenario would generate an American and a world recession. Such a course of events is not viewed as highly probable, but it cannot be ruled out of consideration.

The decline of the dollar benefits American exports and restrains imports. This happens with a time lag. That is precisely what happened when the dollar fell in 1977–78. By 1979–80, the export-import balance improved enough to bring the current account back to equilibrium. If the United States benefits by the dollar depreciation, some trading partners must lose exports and gain imports. The world benefits if the United States coasts in toward a soft landing and especially if the offsets in current balances occur in Japan and Germany. The latter development is more uncertain unless there are additional economic changes, in particular, strong-

er tendencies toward domestic economic recovery in Japan and Germany.

The declines in interest rates that have occurred in many industrial countries, together with the fall of the dollar, are beneficial. Investment in these countries should pick up in response to lower rates. This is the second stage of the expansion that should allow improvement in the economic environment.

The United States is a net debtor, and lower interest rates contribute to the improvement of the current account, as well as to the servicing of domestic debt, which can help to reduce the fiscal deficit—a serious economic handicap for the United States. The developing countries are also significant beneficiaries of lower interest rates because many of them have heavy burdens of debt servicing. Lower interest costs help mitigate, but do not completely offset, the losses of export earnings that are being experienced by the oil exporting countries in the third world.

Uncontrolled inflation can be destabilizing, and that is reason enough to want to see it eradicated. Japan, Western Europe, the United States, and Canada dealt successfully with inflation, bringing it down from ranges of 20–30 percent to 5–10 percent or even lower. These gains, however, had their counterpart costs, namely in the distressing rise of unemployment throughout the OECD countries. Also, the conquering of inflation has not been uniform. There are still serious pockets of inflation in Southern Europe and in the Third World.

The recent slump in world trade has also created problems. Oil and commodity trade have been seriously depressed, but all goods have experienced the slowdown. When the United States grew so strongly in 1984 and imported manufactures at a very high rate, many other countries benefited by export growth. But there was a slowdown in 1985 and 1986, and world trade growth again dropped off. Without more rapid growth of world trade it will be difficult for the heavily indebted developing countries to achieve the trade surpluses they need to service their debts.

Impact on the Soviet Bloc Economies

Several of changes in the world economy are having a significant impact on the Soviet bloc economies.[1] The most important of these is the decline in world oil prices. The depreciation of the dollar, growth in world trade, lower commodity prices and interest rates, and the continued liquidity of world capital markets also have repercussions in the region.

As was pointed out above, one positive effect of lower oil prices is the accompanying increase in aggregate world growth and trade, particularly in Western Europe and Japan. This is expected to increase the demand for the Soviet and East European exports in general, and manufactured goods in particular. The expectation is that the terms of trade will continue to shift in favor of manufactured goods exporters, which is additional good news for most of the East European countries.

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[1] Here we are using the term "Soviet bloc economies" to mean the U.S.S.R. and the six East European countries which are members of the Council for Mutual Economic Assistance (CMEA)—Poland, East Germany, Czechoslovakia, Hungary, Romania and Bulgaria.

While the continued depression of non-fuel commodity prices will have a negative impact for some Soviet bloc exports, this will be partly counterbalanced by the expected weakness in grain prices. With the region's net grain imports expected to remain in the range of 30 to 40 million metric tons a year through the rest of the 1980s, the forecast for a continuation of grain prices at 50 percent to 70 percent of 1980 levels will make a major contribution to reducing the cost of agricultural imports for the Soviet Union and most of the East European countries.

The continuing decline in the value of the dollar will have a negative effect on the Soviet Union. Roughly half of the Soviet Union's hard-currency earnings come from oil exports, the prices of which are set in dollars. However, most Soviet hard-currency imports are in non-dollar-based prices, with the exception of grain imports, which amount to about one-fourth of the total. The decline in the value of the dollar relative to European currencies and the yen will cause an additional deterioration in the Soviet Union's terms of trade with non-socialist countries. The East European economies will be less affected by the dollar's decline, as most of their hard-currency trade—exports, as well as imports—is transacted in European currencies.

The decline in interest rates has substantially reduced the burden of interest payments for the more heavily indebted countries such as Poland and Hungary. Interest on most Soviet bloc hard-currency debt is paid at variable rates, so that the average interest rate paid has dropped from an estimated 12 percent in 1981 to 6.5 percent in 1986. Even though the region's gross external debt went from $90 billion in 1981 to over $100 billion in 1986, interest payments dropped from $11 billion to less than $7 billion.

Recently there has been a dramatic improvement in the reception given most of the Soviet and East European countries on international capital markets. After shying away from East European countries during the first half of the 1980's, Western lenders now appear eager to lend to these countries (Poland being the exception). According to OECD statistics, these countries obtained $4.5 billion in 1985 through international medium- and long-term financing, 50 percent more than the amount borrowed in 1984, and about four-and-a-half times that of 1983.[2]

The credit ratings of the Soviet Union and East European countries have improved considerably as well. This is reflected in the terms that they are able to obtain on their loans, which have become increasingly more favorable since 1983. A major portion of the funds borrowed recently has been used to refinance old debt and to build up reserves, which will help to maintain their improved ratings.

Most of the above developments appear favorable towards an expansion of East-West trade over the next few years. The one change in the global economy that threatens such an expansion is the recent decline in world energy prices.

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[2] OECD, *Financial Market Trends*, Number 35, November 1986, p. 72.

Lower Oil Prices and Soviet Bloc Trade

The continued weakness in world oil prices is having a substantial impact on the Soviet bloc economies and on their economic relations with the West. Since the Soviet Union is a net oil exporter, while the East European countries are net oil importers, the basic effect of a decline in world oil trade prcies should be to worsen the trade balance of the former and improve the trade balances of the latter. While there are a number of complicating factors in the analysis, particularly as regards the impact on the East European economies, this is basically what we expect to happen over the medium term.

The Soviet Union has been exporting about 3.5 million barrels per day (b/d) of crude oil and oil products in recent years. (Soviet oil exports dropped suddenly in 1985 due to production problems early that year. However, as production revived in late 1985 and 1986 so did Soviet sales abroad.) About half of Soviet oil exports have gone to non-socialist countries in recent years, with most of this amount being sold at world market prices. At this level of exports the Soviet Union loses $550 million a year in hard-currency export revenues for each one-dollar drop in the price of oil.

Even in the face of lower world market oil prices, it appears that the Soviet Union is continuing to give high priority to the production and export of oil, with exports to both Eastern Europe and the West remaining relatively stable. There are several reasons for the Soviets to continue in this manner over the next few years. With the great uncertainty in the oil markets, the Soviets will naturally be cautious about making any change that could have long-term implications. Also, given their large hard-currency reserves and access to Western credits, they are probably not under any great pressure to change their trading policy immediately. This conservatism is reinforced by the Soviets' own view that oil prices will go up again in the near future.

The East European countries import about 1.7 million barrels/day of oil each year, mostly crude, three-fourths of it from the Soviet Union. They also export about 440,000 b/d of oil each year, almost all in the form of products sold in Western Europe. In recent years Eastern Europe has earned roughly a fifth of its hard currency from the export of crude oil and products. Whether the region can maintain this trade with lower oil prices, and how profitable it will be, depends on the trade arrangements they negotiate with Soviet and other crude suppliers.

However, on balance, a decline in oil prices should help Eastern Europe considerably. The degree of the impact is difficult to tell, as it is complicated by the disparity in price setting between intra-CMEA trade and "free" world trade. Unless world oil prices go even lower, it is unlikely that East European importers would find it cheaper to switch to non-Soviet oil supplies for most of their crude. (While the nominal price that East European countries paid for Soviet oil in 1985 was an estimated 25 rubles per barrel—or $30/barrel at official exchange rates—it is likely that the real cost, in terms of goods the East European countries provide the Soviet Union in payment, was closer to $15 to $20 a barrel.) Other reasons why East European countries are not likely to switch to free-

market oil are: most of their refining capacity is designed for Soviet crude; they would probably not want to risk losing preferential access to Soviet supplies if world prices went up again; and they would have to allocate hard currency to pay for this oil, or find oil exporters willing to take their goods in barter.

However, it should be stressed that even if the price that Eastern Europe pays for Soviet oil is approaching or exceeding world oil prices, the region will soon benefit substantially from the recent decline in world prices. If the Soviets continue to use a five-year moving average of world oil prices to set the price for oil they sell to Eastern Europe, then the price of a barrel of Soviet oil in transferable rubles (TR) should drop quickly over the next few years, falling to perhaps 10 TR/barrel by 1991. (This assumes that world oil prices rise gradually to $25 a barrel and that the value of the TR in dollars will move in step with expected changes in the value of a weighted basket of Euro-currencies relative to the dollar.)

Outlook for the World Economy

Table 1 provides a summary of a "baseline" forecast for the world economy over the next five years (1987–91).[3] This forecast assumes a continuation of current economic policies by the major economies.

While it appears unlikely that the world economy will suffer a recession over the next few years, world GDP growth is expected to show only moderate growth, in the range of 2 percent to 3.5 percent per year. This would support an expansion of world trade volumes of about 2.5 percent to 4.5 percent per year (9.5 percent per year on average in nominal dollar terms). Although not spectacular, such performance would be better than that achieved over the first half of the 1980's.

As the U.S. begins to bring down its budget and trade deficits it will give up its role as the engine of world growth. Much depends on the degree to which Japan and Europe assume this role. Rapid growth in the newly industrialized Asian economies and the People's Republic of China should also help to maintain momentum in the world economy.

Overall, developing countries are expected to grow by a percentage point or more above the world average. However, against this seemingly superior performance, we must place their 1 percent to 2 percent higher rate of population expansion.

These forecasts may appear deceptively calm and peaceful. They indicate stable growth without inflation; they are manifestations of a "soft landing" for the U.S. dollar; and a global crisis arising from the developing countries' debts is not foreseen. But these broad aggregates cover up many problem areas or just fail to deal with some disturbing issues. It is not only disparities in the fortunes among countries that give rise to world economic problems; there are also issues that ultimately affect all countries.

There is first a pressing problem of unemployment in Western Europe and, to a lesser extent, in North America. The unemploy-

[3] This forecast was prepared by Wharton Econometric Forecasting Associates and is detailed in Wharton's *World Economic Outlook*, Volume 8, Number 4, December 1986.

ment problem is also serious in many developing countries, but accurate unemployment statistics are not available for most of these countries. The growth rates projected are simply not strong enough to bring down unemployment. We would have to realize at least one more full point, on average, in growth in order to have much immediate impact on unemployment, and even with that kind of expansion there would still remain many structural problems in labor markets that would not be resolved. Youth unemployment, in particular, would remain as a vexing problem.

The world recession of the early 1980s brought with it a depressed state of the main world commodity markets. There is oversupply in many agricultural commodities and also in many lines of industrial materials. Some material markets are feeling the pressure of slow business conditions but others are going through an industrial transformation in which some traditional commodities are being technologically displaced. The fall in the dollar should, under normal circumstances, lead to price rises of dollar-denominated commodity prices, but that is happening only on a small scale at this time.

Two other major problems are the large surpluses and deficits in external balances in many countries. The most noteworthy cases of disequilibrium are the U.S. deficit against the Japanese and German surpluses. Dollar depreciation and harmonization of domestic policies across countries may lead to eventual improvement, but at the present time, the U.S. deficit is so large and pervasive that it generates widespread demands for protectionist legislation that could lead to debilitating trade wars. At the current time, a close watch is being placed on movements of the dollar and trade balance adjustment to see if enough improvement can be realized in order to hold back the forces of protectionism.

Another serious imbalance in the world economy is the prevalence of high indebtedness of some key countries. In Latin America, the worst problems are in Argentina, Brazil, Mexico, Venezuela, Peru, Bolivia, and Chile. The Philippines and Indonesia pose problems in the Far East. Nigeria is in trouble in Africa and Poland in Eastern Europe. These are only the most prominent cases; many others exist. Lower interest rates, higher commodity prices, and world growth can all help alleviate the situation but some more fundamental adjustments will probably be needed. Meanwhile, stability of the world's entire financial system is at stake.

The overall prospects for the developing countries are uncertain. Famine, debt burdens, sluggish growth (recession in some areas), and pockets of inflation are all problems. Steps must be taken to allow the developing countries to participate in the general improvements in living standards if there is to be politico-economic stability in the world over the remainder of this century.

Outlook for the Soviet Bloc Economies

Tables 2 and 3 summarize some key features of a forecast for the Soviet bloc economies, focusing on the region's trade and financial

relations with the rest of the world. This forecast is based on the world economic outlook described above.[4]

The Soviet Union and most of the East European countries are planning for more rapid growth in 1986–90 than was either planned or achieved over the last five years. Some objective reasons merit this optimism. The economic situation going into the new Plan period appears more favorable for most East European countries than it did before the last Plan period. At that time it was already becoming apparent that a substantial adjustment of the East European external accounts was in order due to the mounting debt in the region. Now that the most difficult adjustments have been made, most East European planners are expecting the debt-servicing burden to lessen over the next few years.

One problem in meeting their growth targets that a number of the East European economies will face for the next five years is suggested by the declines in investment that occurred during 1981–85. This has caused a sharp slowdown in the modernization and replacement of capital stock in these countries, which could make it difficult for them to realize the volumes and quality of production targeted. It will also affect their foreign trade performance, especially in manufactures, where the lack of modernization is making their exports less competitive on world markets. To compensate for this, the targeted rates of investment growth have been increased for the new Plan period.

Soviet hard-currency exports are projected to increase at an average annual rate of 6 percent (in nominal dollar terms), while the growth rate foreseen for East European exports is near the 9 percent average annual rate of growth projected for Western imports. These forecasts are based on the projected growth of import demand in the rest of the world and trends in prices of major categories of traded goods.

The Soviets are trying to compensate for part of the fall in their hard-currency oil export revenues by increasing exports of other goods, selling gold, and borrowing. The second most important hard-currency earner is natural gas sold to Western Europe. Such gas exports are expected almost to double in volume during the current Plan period (going from 32 billion cubic meters in 1985 to 60 bcm in 1990), but gas prices will go down if oil prices remain depressed, as their gas is sold under oil price-indexed contracts. The Soviets will probably not be able to realize more than $2 to $4 billion from gold sales in any one year, since they would not want to increase gold sales enough to drive prices down. The Soviet Union is trying to increase exports of non-fuel raw matrials and manufactured goods. But the aggregate impact of even a successful effort will not be great since almost two-thirds of Soviet hard-currency earnings come from oil, gas or gold sales. Thus the Soviets have begun to borrow more heavily.

In 1985 the Soviet Union was able to borrow more than $1.5 billion on the Western syndicated-loan market and another $1.5 during the first nine months of 1986, all at excellent terms. It is likely that the Soviets will continue to use such financing to help

[4] Details for these forecasts are provided in Wharton's *CPE Outlook for Foreign Trade and Finance*, Volume 2, Number 2, December 1986.

compensate for future shortfalls in export earnings. However, the Soviets will be careful not to go to heavily into debt, and they are likely to cease borrowing if lending terms deteriorate.

Obviously, the Soviets will be faced with the prospect of having to reduce Western imports if oil prices remain low and they do not increase the volume of their oil exports to the West. If the Soviets are forced to cut back on imports from the West, it is likely that they will seek substitutes in Eastern Europe. While East European technology may lag that of the West, in certain areas it is superior to Soviet technology. Thus the Soviets are likely to put pressure on Eastern Europe to supply better quality goods that can substitute for imports from the West. This will be most important in the case of machinery and equipment embodying more sophisticated technology.

The key question is whether or not Eastern Europe can supply goods in sufficient quantity and quality to meet Soviet needs. Already machinery and equipment account for three-fifths of East European exports to the Soviet Union and it will be difficult for most East European countries substantially to increase their exports to the Soviet Union. Domestic capacity is limited, and they need to maintain their current levels of exports to the West if they are to be able to service their debts. In addition, there has been a significant reduction in investment in the region over the last few years. This has left these economies with an aging and depleted capital stock, and a pent-up domestic demand for capital goods.

Soviet pressure on Eastern Europe is likely to be intense. At the CMEA summit in 1984, the Soviets made clear that their continued supply of energy to the region depended upon Eastern Europe supplying the USSR with high quality goods, embodying technology at world standards. The Soviet Union has also made it clear that East European countries (with the exception of Poland) would have to reduce their bilateral trade deficits, and start paying off the ruble debts that they accumulated over the past decade. The drop in oil prices is simply adding greater urgency to the Soviet demands.

Even with the trade difficulties being faced by the Soviet Union due to low oil prices, the Soviet bloc countries will be considerably less constrained by their indebtedness to the West over the forecast period than they were during the first half of the 1980's. In large part this is due to a shift in the debt burden from the more fragile East European economies to the less heavily indebted Soviet economy. If our trade and borrowing projections prove correct, the real burden of debt servicing for the Soviet Union will increase while the burden for Eastern Europe is expected to decline.

Hidden within the aggregate figures are the less optimistic projections for a few East European debtors. Debt-service burdens will remain high in Poland and Hungary. However, even for these countries we expect the burden to diminish considerably by the end of the decade. The only country for which we are predicting a substantial increase in debt-service burden is the Soviet Union. But due to the relatively low level of the Soviet's current indebtedness, the increase in Soviet payment requirements should not pose any serious problem.

A Longer Term Perspective

The global analysis presented here focuses mainly on the near term recovery process. But for the longer run the underlying growth trends will be predominant, and foremost in this area is the emergence of new technologies. The great transformations that are now taking place give rise to short-run problems of labor displacement, the phasing-in of new sectors, and the phasing-down of traditional sectors. That is why we find unemployment and excess capacity in steel, other metalworking industries, and in manufacturing at large. The principal issue of upside risk in the consensus forecast is that new investment will be strong and that large scale productivity gains will be realized. The choices between work and leisure, spending and saving, and unemployment and retraining pose difficult decisions. In a sense they are being made now in both the OECD and the Soviet bloc countries. A few of the developing countries are also participating in the development of the new technologies and are not simply waiting to realize the benefits after they have been successfully put in place in the advanced countries. But vast differentials are apparent even among the countries actively engaged in developing the new technologies. The problems of technology transfer is important in this respect.

Automation, robotization, and computerization are clearly visible in the United States, Japan, parts of Western Europe, and a few other countries. If the techniques being developed now become widely diffused throughout the world, then a high growth scenario has a good chance of being achieved in the total world economy.

Technological progress has always been given a major role in Soviet and East European plans. However, now it appears to be the dominant theme, for several reasons. First, technological progress is seen as the major source of productivity increases and the key to growth. Second, the lag in the technological level of their products is hurting the region's trade with the rest of the world.

Each country in the region has plans to strengthen its own technological capabilities. The general trend is to emphasize the need for linking scientific research more directly to the production process, since the weakest link in the system is in the application of new technology.

However, most of these countries are too small to be able to rely on their own resources to develop the technology they need. Thus region-wide cooperation is also stressed in the Plans. The "Comprehensive Program for Scientific and Technological Cooperation" among the Soviet and East European countries serves as the blueprint for regional efforts to find ways to cooperate in this effort, and it is referred to in each country's Plan.

So far the Comprehensive Program and its predecessor cooperation agreements have not been as successful as their participants had hoped. Several basic impediments to integration—particularly the inadequacies of the price system and the lack of a regional convertible currency—have yet to be overcome. Only in areas such as computer technology, where the advantages of cooperation and specialization far outweigh the disadvantages, has substantial progress been made on a region-wide basis. However the pressures for improvement noted above, and the limited availability of hard curren-

cy with which to purchase Western technology, make regional cooperation more attractive at this time.

For the same reasons a number of East European countries are attempting to increase the scope of industrial cooperation and joint ventures with Western companies. Recently the Soviet Union has indicated an interest in this area as well. It could be that recent changes in world economic conditions and perceptions will put new life into this form of East-West cooperation.

TABLE 1.—WORLD FORECAST SUMMARY

[Percent change unless otherwise noted]

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Real gross domestic product:											
World	1.8	0.5	2.4	4.1	2.9	2.4	2.7	2.9	2.7	2.1	3.4
OECD countries	1.8	−.2	2.4	4.5	3.0	2.5	2.7	2.8	2.4	1.4	3.4
Developing countries	1.2	.5	.5	2.6	2.2	.9	2.4	3.4	3.5	4.0	4.0
Centrally planned economies	2.1	2.7	3.7	3.9	3.3	3.5	2.8	3.0	3.1	2.9	3.1
OECD inflation (consumer prices)	10.1	7.9	5.6	5.4	4.9	3.0	3.4	4.2	4.7	4.8	4.4
U.S. Dollar exchange rate (MERM weights)	12.4	11.8	5.9	7.9	4.2	−18.3	−10.6	−8.6	−3.9	−.9	1.9
Interest rates (LIBOR)	16.8	13.2	9.7	10.9	8.4	6.5	6.4	7.7	8.6	7.8	7.4
World trade volumes:											
Total exports	1.0	−.4	2.2	8.3	3.3	3.0	3.3	4.4	3.2	2.5	4.0
Fuels	−12.4	−6.9	−.6	−1.9	−5.9	3.4	1.5	5.8	3.7	2.4	4.1
Other commodities	6.1	2.8	.3	8.0	9.6	5.7	4.7	4.9	2.9	4.0	3.3
Manufactured goods	2.9	0	3.9	10.9	3.8	2.3	3.5	4.0	3.3	2.1	4.2
World trade prices:											
Total exports	−3.3	−6.0	−4.5	−2.5	−1.8	4.1	6.1	7.7	6.1	5.0	4.3
Fuels	9.2	−4.6	−10.8	.7	1.7	−38.7	.6	8.8	8.9	10.7	9.5
Other commodities	−7.9	−11.8	.3	−3.1	−9.0	.3	0	3.4	5.4	4.0	5.5
Manufactured goods	−4.4	−3.9	−3.6	−2.7	.4	17.1	8.2	8.5	5.9	4.6	3.2
Oil export price	10.2	−4.3	−12.4	−2.9	−2.5	−49.5	7.1	11.3	10.8	13.5	11.9
Wheat export price	.9	−10.3	0	−3.4	−4.7	−12.5	−27.2	−2.6	8.0	5.3	4.7
Other cereals export price	−4.1	−12.6	−3.5	−8.7	−19.1	−10.3	−26.4	−1.2	3.5	4.0	7.6
Current account balances (billions of U.S. dollars):											
United States	6.3	−9.2	−40.8	−106.5	−117.7	−135.7	−138.3	−135.2	−131.1	−101.9	−113.7
Japan	4.8	6.8	20.8	35.0	49.2	81.5	83.2	77.1	72.1	53.0	55.7
Europe	−23.7	−17.8	2.3	13.8	22.4	58.6	50.2	44.9	33.5	6.0	−7.7
Developing countries	−37.3	−80.5	−50.9	−35.6	−9.7	−32.8	−24.5	−14.8	−5.8	2.3	11.5
Centrally planned economies	−9.0	−2.9	11.2	10.9	−9.5	−11.5	−1.5	1.9	0	3.8	5.7

Figures for 1986 are estimates and those for 1987–91 are forecasts.

Source: Wharton Econometric Forecasting Associates, Inc.

TABLE 2.—SOVIET UNION

[In billions of U.S. dollars]

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Merchandise trade balance	−1.4	2.6	3.4	4.2	0.7	1.1	0.3	0.5	0.1	0.3	0.7
Merchandise exports	32.0	35.5	35.1	34.5	29.7	30.2	29.9	31.8	34.2	37.1	40.4
Change (percent)	1.9	11.0	−1.1	−1.7	−13.9	1.5	−.9	6.3	7.4	8.4	9.1
Merchandise imports	33.4	33.0	31.7	30.4	29.0	29.1	29.6	31.4	34.1	36.8	39.7
Change (percent)	11.3	−1.3	−3.8	−4.2	−4.4	.2	1.7	6.0	8.7	7.9	8.0
Services and income, credit	5.2	5.4	5.5	5.9	5.6	5.6	5.9	6.4	6.8	7.1	7.5
Services and income, debit	−5.9	−6.3	−6.2	−6.2	−6.2	−6.3	−6.8	−7.6	−8.3	−8.6	−8.8
Net transfers	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5
Current account balance	−1.6	2.2	3.3	4.4	.6	.9	−.1	−.3	−.9	−.7	−.1
Net direct and portfolio investment	0	0	0	0	0	0	0	.2	.3	.4	.5
Other non-debt creating items	−2.3	−1.7	−4.1	−4.9	−5.5	−2.1	−2.3	−1.7	−1.2	−.6	.5
Net new borrowing	3.9	−.5	.8	.5	4.9	1.3	2.4	1.7	1.8	.9	−.9
Exchange rate adjustment	−.7	−.3	−.5	−.7	1.1	1.3	1.8	1.2	.8	.3	−.8
Stock-flow reconciliation	0	0	0	0	0	0	0	0	0	0	0
Change in gross debt	3.2	−.8	.3	−.2	6.0	2.6	4.2	2.9	2.6	1.3	−1.7
Gross external debt	21.0	20.2	20.5	20.3	26.3	28.9	33.1	36.1	38.6	39.9	38.2
Short-term debt	11.0	9.3	9.1	8.7	8.6	8.5	8.3	8.8	9.6	10.4	11.2
Medium-and long-term debt	10.0	10.9	11.4	11.6	17.7	20.4	24.8	27.2	29.0	29.6	27.0
Reserves	8.5	10.0	10.9	11.3	13.1	13.8	13.9	14.1	14.5	14.7	14.9
Net external debt	12.6	10.2	9.6	9.0	13.3	15.1	19.2	21.9	24.2	25.2	23.3
Interest payments	2.4	2.5	2.1	2.2	2.0	1.8	2.0	2.5	2.9	2.9	2.7
Average interest rate (percent)	12.4	12.1	10.5	10.7	8.6	6.6	6.4	7.3	7.8	7.3	6.8
Principal repayments	10.8	13.5	12.0	12.2	11.7	12.6	13.1	13.9	15.0	16.2	17.1
Short-term debt repayments	8.5	11.0	9.3	9.1	8.7	8.6	8.5	8.3	8.8	9.6	10.4
M&LT debt repayments	2.3	2.5	2.7	3.1	3.0	4.0	4.6	5.6	6.1	6.6	6.7
Gross financial requirments	13.2	16.0	14.1	14.3	13.7	14.4	15.1	16.4	17.9	19.1	19.7
Net financial transfers	1.5	−3.0	−1.3	−1.7	2.9	−.6	−.4	−.8	−1.1	−2.0	−3.5
Interest/exports of goods and services (percent)	6.5	6.1	5.2	5.4	5.7	5.1	5.5	6.6	7.1	6.5	5.6
Total debt service/exports of G&S (percent)	35.6	39.0	34.7	35.4	38.9	40.3	42.1	43.0	43.6	43.2	41.2
Gross debt/GDP (percent)	1.7	1.5	1.4	1.4	1.6	1.6	1.7	1.7	1.6	1.5	1.4

GDP billions of 1980 U.S. dollars	1,129	1,158	1,197	1,214	1,228	1,269	1,295	1,322	1,351	1,381	1,412
Change (percent)	1.5	2.5	3.4	1.4	1.2	3.3	2.1	2.1	2.2	2.2	2.3
GDP per capita 1980 U.S. dollars	4,236	4,306	4,413	4,433	4,445	4,564	4,632	4,703	4,783	4,862	4,946
Change (percent)	.7	1.7	2.5	.4	.3	2.7	1.5	1.5	1.7	1.7	1.7

TABLE 3.—EASTERN EUROPE

[In billions of U.S. dollars]

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Merchandise trade balance	1.1	6.0	6.1	6.8	4.4	2.2	3.4	3.8	4.2	4.1	4.3
Merchandise exports	32.3	32.2	32.7	34.1	32.9	33.0	35.5	39.1	42.8	46.3	50.7
Change (percent)	−.2	−.3	1.6	4.4	−3.8	.4	7.5	10.2	9.5	8.1	9.5
Merchandise imports	31.2	26.1	26.6	27.4	28.4	30.8	32.1	35.3	38.7	42.2	46.4
Change (percent)	−12.4	−16.2	1.7	3.1	3.8	8.5	4.1	10.1	9.4	9.2	9.9
Services and income, credit	4.6	4.4	4.4	4.9	4.9	4.9	5.2	5.8	6.3	6.7	7.2
Services and income, debit	−12.1	−10.9	−9.5	−9.8	−9.2	−8.7	−8.9	−9.9	−10.7	−10.9	−10.9
Net transfers	1.3	1.0	1.1	1.2	1.2	1.3	1.4	1.5	1.6	1.7	1.8
Current account balance	−5.7	−.6	1.9	3.3	1.3	−.6	.8	.7	1.0	1.2	1.8
Net direct and portfolio investment	0	0	0	0	0	0	0	0	0	0	0
Other non-debt creating items	−.1	.8	−3.0	−2.2	−3.3	1.3	.7	−.4	−.4	−.8	−1.3
Net new borrowing	5.8	−.2	1.1	−1.0	2.0	−.7	−1.5	−.4	−.6	−.4	−.6
Exchange rate adjustment	−3.7	−2.8	−3.1	−4.1	5.2	4.7	5.3	2.8	1.6	0.8	−1.5
Stock-flow reconciliation	.2	.3	1.0	2.6	−1.6	0	0	0	0	0	0
Change in gross debt	2.2	−2.7	−1.1	−2.6	5.2	4.1	3.8	2.4	1.0	.4	−2.1
Gross external debt	69.2	66.5	65.4	62.8	68.0	72.1	75.9	78.2	79.2	79.6	77.5
Short-term debt	13.3	10.4	9.8	9.4	11.3	10.7	11.0	11.6	12.0	12.7	13.8
Medium and long-term debt	55.9	56.1	55.6	53.4	56.7	61.3	64.8	66.6	67.3	66.9	63.7
Reserves	6.0	5.6	8.6	10.7	13.9	12.6	11.9	12.2	12.6	13.4	14.6
Net external debt	63.2	60.9	56.8	52.1	54.1	59.4	63.9	66.0	66.7	66.2	62.9
Interest payments	8.6	7.7	6.2	6.0	5.8	5.0	5.1	5.7	6.1	5.9	5.5
Average interest rate (percent)	12.7	11.3	9.4	9.3	8.9	7.2	6.8	7.4	7.8	7.4	7.0
Principal repayments	22.1	20.6	19.2	19.5	18.6	20.6	18.5	20.0	21.1	22.0	22.7
Short-term debt repayments	14.6	12.3	10.9	9.4	9.0	11.3	10.7	11.0	11.6	12.0	12.7
M&LT debt repayments	7.5	8.3	8.3	10.1	9.5	9.3	7.8	9.0	9.5	10.0	10.1

TABLE 3.—EASTERN EUROPE—Continued

[In billions of U.S. dollars]

	1981	1982	1983	198-	1985	1986	1987	1988	1989	1990	1991
Gross financial requirements	30.7	28.3	25.3	25.5	24.4	25.6	23.6	25.7	27.2	27.9	28.2
Net financial transfers	−2.9	−7.9	−5.1	−7.0	−3.8	−5.7	−6.5	−6.1	−6.8	−6.3	−6.1
Interest/exports of goods and services (percent)	23.4	21.0	16.6	15.4	15.3	13.3	12.4	12.7	12.5	11.1	9.5
Total debt service/exports of G&S (percent)	83.2	77.4	68.2	65.3	64.6	67.6	57.9	57.4	55.4	52.6	48.7
Gross debt/GDP (percent)	13.5	12.7	12.3	11.7	11.2	10.5	9.8	9.1	8.3	7.7	7.1
Change (percent)	−1.5	0.6	1.9	3.2	1.6	1.9	2.4	2.2	2.2	2.2	2.1
GDP per capita (1980 U.S. dollars)	3,971	3,971	4,030	4,143	4,190	4,256	4,337	4,413	4,491	4,570	4,646
Change (percent)	−2.1	0	1.5	2.8	1.1	1.6	1.9	1.7	1.8	1.8	1.7

NOTES ON TABLES 2 AND 3

The series presented in these tables are based on estimates and forecasts prepared by Wharton Econometric Forecasting Associates.

Only non-socialist trade and convertible currency debt and payments are included in these accounts.

For some countries the *merchandise trade balance* figures are adjusted for coverage and payments leads and lags before they are entered into the current account balance.

Other services and income covers shipping and other transportation payments, travel and tourism payments, investment income, interest payments and miscellaneous other payments for goods and services. *Net transfers* include both private and official unrequited transfer payments.

The *current account balance* is the sum of the (adjusted) merchandise trade balance, net services and income, and net transfers. A summary of the counterbalancing capital account components are shown on the following three lines.

The entry labeled *other non-debt creating items* includes changes in reserves and arrears, gold sales, errors and omissions, counterpart and other items.

Net new borrowing is estimated on the basis of each country's capital account. Thus it differs from the change in gross debt by the amount of exchange rate adjustments and unrecorded capital out-flows.

The *exchange rate adjustment* refers to the change in the nominal dollar value of gross debt due to appreciation or depreciation of the dollar relative to other currencies in which that country's debt is held. (When the dollar is strengthening against other currencies, this tends to reduce the dollar value of the non-dollar portion of a country's debt causing a negative entry in this line.)

The figures for *stock-flow reconciliation* show the difference between estimated capital account transactions and changes in the level of gross debt (after deduction of exchange rate adjustments). This discrepancy is due to errors and inconsistencies in both stock and flow accounts or estimates.

Gross external debt is the end-year value of all external debt, both short-term (with repayment due in one year or less) and medium- and long-term and including use of IMF credits. Only disbursed amounts are included.

Only BIS-area bank liabilities to the Soviet-bloc countries are included in line labeled *reserves*. *Net debt* is defined as gross debt minus these reserves.

Interest payments are gross payments on all debt (including short-term debt). The *average interest rate* is calculated by dividing these interest payments by the average level of gross debt during the year.

SOVIET INTERNATIONAL FINANCIAL POLICY: TRADITIONAL FORMULAS OR NEW INNOVATIONS?

By Lawrence J. Brainard*

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SUMMARY

The paper assesses the factors that will influence Soviet foreign financial policy in the coming years. Particular attention is given to external factors, such as the world economic outlook and its effects on Soviet strategy, the trend toward financial innovation in western markets and the example of policy innovations in other socialist countries. The conclusions suggest that, despite increasing demands for foreign capital, changes in Soviet financing policy are likely to be evolutionary rather than radical in nature. The fundamental challenge for Soviet leaders is how to use foreign resources more efficiently, not how to borrow more.

I. INTRODUCTION

In deciding upon economic strategies for the future, Soviet planners must determine the scheduling of the availability of resources, both domestic and foreign. The substantial decline in oil and other commodity prices since 1981 has contributed to a deterioration in Soviet export earnings and in the country's foreign exchange position. The issue of the role of foreign capital in future economic strategies, therefore, is emerging as one of the key decisions facing the new Soviet leadership during the current 1986–90 five-year

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plan. Decisions about international financing are directly linked to the allocation of resources at home between competing civilian and military uses, as well as to the issue of economic reform.

Soviet financial strategy must consider several interrelated aspects of the country's foreign economic transactions. One is the actual transfer and use in the economy of foreign machines, licenses or processes that embody foreign technical know-how. Financial policy must consider the rate of return to such expenditures, since this will be a major factor influencing decisions on the desired level of indebtedness, i.e. by determining the ability of the economy to service the debt incurred to import such technology. Financial policy, therefore, must be based on a realistic assessment of the productivity of foreign capital in the domestic economy, including the potential contribution of economic reform to such productivity. A closely related consideration is the longer-term outlook for export sales. For traditional commodity exports such as oil and natural gas, the primary concern is future price trends. For manufactured exports, the primary concern is competitiveness of Soviet goods in western markets, including styling, quality, servicing and price. Finally, financial policy must also consider the potential sources and volume of available external financing and the likely terms and conditions associated with such credit.

Each of these aspects presents substantial uncertainty to the Soviet decision maker, particularly given the experience of the past 5–10 years which reflected external economic volatility and domestic economic shortcomings. A western assessment of future Soviet international financial policy cannot know how these factors are likely to be weighted in Soviet decision making. The discussion which follows highlights what we know best, namely the potential role of external factors as influences on future Soviet financial policy. The discussion of internal influences such as economic reform and trends in productivity on such policy is incomplete, inasmuch as our knowledge of such factors is limited.

II. Historical Developments in Soviet International Financial Policy

During the 1950's Soviet financial ties with international financial markets were rather limited, consisting of short-term financing of imports and exports. During the 1960's the Soviet Union expanded its involvement in major western financial markets through two wholly-owned subsidiary banks, Eurobank in Paris and Moscow Narodny Bank in London. These banks provided access to the growing interbank market for Eurodollars, where short-term credit unrelated to trade transactions could easily be raised. In the 1970's Soviet financial activity expanded into long-term borrowings from western governmental agencies and the number of scope and activity of Soviet-owned banks in the West continued to grow. During the same period the Soviet Foreign Trade Bank raised several syndicated long-term credits from western commercial banks, but the bulk of Soviet activity in private credit markets remained short-term in nature.

One of the notable features in Soviet credit policy at this time was the heavy dependence on official credits. At the end of 1977,

for example, over 50 percent of the estimated $18 billion in gross foreign debt was accounted for by official credits from western governments. This proportion was the highest of any country in Eastern Europe and was substantially greater than in developing countries such as Brazil and Mexico, where the ratio at this time was only about 15%. Soviet bankers preferred official credits over bank credit by reason of fixed rates of interest rather than the floating market interest rates of bank credits. Another reason was the priority given to large projects which were typically tied to compensation agreements—the natural gas for pipe deal is an example. Such deals were too large to be handled by normal bank credits; the direct participation of western governments in the financing provided an underwriting of the risks for the western firms. From their perspective, Soviet leaders believed that government-to-government agreements reduced their risks associated with western sales, since any economic problem would be viewed in the context of overall bilateral relations and not be limited to its economic dimensions.

The emphasis on large, resource-based projects and official credits reflected two characteristic themes in Soviet policy at this time. One was a bias in Soviet planning toward such large-scale undertakings, best symbolized by the Baikal-Amur Railway project. The priority accorded the large infrastructure projects reflected bad economic judgment. Such investments required heavy commitments of resources, but promised economic returns only far in the future. And in most cases supplementary investments were required in order to capture the economic benefits of the projects. Because labor and capital resources were strained by commitments to these priority projects, many smaller investments with short-term payoffs were neglected. This acted to retard the overall growth rate at this time.

A second theme in Soviet policy was the reliance on political agreements rather than economic competitiveness as the basis for access to western markets and credits. For Soviet leaders, the importance of detente as a precondition for the expansion of East-West trade reflected a mistrust of western markets and western politicians, as well as a lack of commitment to fundamental economic reforms at home. Rather than compete on terms set by the markets, Soviet negotiators offered huge, "historic" deals in return for western political commitments securing market access and credits. The willingness of western governments to deal on Soviet terms gave Soviet leaders the confidence to make additional commitments to these huge projects without altering priorities for the military and it allowed them to postpone dealing with the thorny problem of economic reform.

These Soviet policies began to unravel after 1975. U.S.-Soviet relations deteriorated markedly in the wake of the Jackson-Vanik Amendment and other congressional restrictions on trade and Export-Import Bank credits. The Soviet economy, meanwhile, was stagnating, due in large part to the overcommitment of resources associated with the investment policies described above. In response to these developments and to a concern that a further growth in indebtedness could lead to political leverage applied by the West, a change in Soviet financing policy was made during

1976. Orders for western machinery and equipment were cut sharply in 1977 and subsequent years. The priority now was to balance payments flows with the West and to prevent an increase in the country's indebtedness.

Although Soviet leaders eventually concluded a major natural-gas-for-pipes deal with a German-led consortium in 1981, an important turning point in Soviet financing strategy had been reached in 1976. Other countries in Eastern Europe and in the developing world were rapidly increasing foreign borrowing at this time to compensate for domestic economic shortages. Soviet policy, however, chose austerity in the form of import cutbacks to achieve balance in international payments. Such a policy option was made more bearable thanks to significant increases in prices of Soviet exports in the period up to 1981. But even after 1981, when the Soviet terms of trade worsened substantially, policy makers were quick to make the necessary adjustments to maintain net international indebtedness virtually constant at $10–11 billion, the same level reached in 1977.

III. An Evaluation of Past Policies

From the viewpoint of the current Soviet leadership, the 1976 decision to limit the growth in indebtedness was a wise one. The Soviet Union was spared the severe adjustments in economic policy that were forced on Poland and other developing countries when the global debt crisis emerged in 1981–82. More importantly, perhaps, Soviet leaders were successful in blunting the efforts of the Reagan administration to apply economic leverage during the early 1980's in matters relating to grain sales, official western credits and the gas pipeline deal. These results will clearly be influential in the development of Soviet international financial policies for the future. A minimum requirement of any future international financial policy is that it not put the Soviet Union in a position where the West might effectively use economic leverage for political ends.

At the same time, however, Soviet leaders must also realize that the austerity policies have imposed significant costs on the Soviet economy in terms of benefits foregone. The economy has been denied western technology on a broadly diffused basis. Much of the credit used in recent years was concentrated in the importation of pipeline equipment and materials. The technology embodied in such imports was for the most part already known to Soviet industry, but Soviet firms could not meet the priority delivery schedules for these projects. Credit policy, therefore, contributed little to solving the fundamental problem of the economy—a slowing of the growth rate due to lagging productivity and technological obsolescence.

As was true some fifteen years earlier, the use of western credit offers today's Soviet leaders one avenue through which the economy's performance might be substantially improved in coming years. The issue is whether changes in Soviet international financial policy could—without exposing the country to an unacceptable degree of economic leverage from the West—bring significant benefits to the economy. A more active, though still cautious, expansion of financial interactions with the West, coupled with a new set of

domestic economic priorities, could very likely find a place on Mr. Gorbachev's agenda for the revitalization of the Soviet economy. The following section explores some of the external developments that are likely to shape such a policy.

IV. External Influences on Soviet Financial Policy

A. GLOBAL ECONOMIC OUTLOOK

Since the last recession in 1981–83, the world economy has struggled to overcome strong deflationary forces stemming from the global debt crisis, high real interest rates, rising protectionism and—beginning in 1985—rapid appreciation of the yen and most European currencies against the dollar. World economic growth appears likely to continue at modest levels in the coming few years, but the level of aggregate growth is less important than the uneven impact of the abovementioned factors on individual countries. Major structural changes in the global economy are being propelled by the massive imbalances in trade positions of major industrial countries, difficult adjustment problems facing highly indebted developing countries and shifting fortunes of individual economic sectors due to depressed commodity prices and sharp swings in foreign exchange rates.

The following appear to be key issues for Soviet planners:

Global deflation.—How long will commodity prices—and energy prices in particular—remain depressed; will OPEC be successful in pushing oil prices back up in the near term? How great is the risk of recession in the next 2–3 years?

Protectionism.—How will trends toward greater protectionism in developed industrial countries affect Soviet efforts to diversify away from dependence on exports of energy and other commodities?

Foreign exchange rate volatility.—How is the decline of the dollar affecting Soviet net earnings from trade and the country's net international indebtedness; could a collapse of the dollar lead to sharp increases in interest rates?

Global trade imbalances.—How are the huge trade surpluses in Japan and Germany and the United States trade deficit likely to be reduced; do the growing net asset position of Japan and Germany and the net indebtedness position of the United States imply a redistribution of economic power among the major industrial powers? What risks or opportunities for the Soviet Union might be associated with such developments?

Global debt.—How are western policies to manage the LDC debt crisis likely to evolve; what risks would LDC defaults pose for the international financial system and activity by Soviet banks?

These are complex, interrelated issues. If there is a dominant theme, it is the contrast of growing trade imbalances with greater financial liberalization (described in greater detail below). The international financial system has facilitated the creation of debt, which has made it easy for countries to finance balance of payments deficits. But the gobal trading system has not facilitated the servicing of this debt by the debtor countries.

Depressed commodity prices reflect conditions of oversupply, due in large part to debtors' economic adjustment efforts necessitated by excess debt levels built up in the past. Protectionism, in turn, reflects the relative importance that politicians in developed countries place on domestic concerns over international economic adjustment. And although the United States has generally supported free trade in the past, there is concern that future U.S. policies may turn more protectionist under Congressional pressures for more effective action to correct existing economic imbalances—the growing net international debtor position, continuing budget deficits and a large trade deficit.

The intertwining of trade blockages and financial market liberalization reflects a fundamental contradiction in the global economic outlook. If it is to be sound, credit created within any financial system must be tied in one way or another to production—a company's cash flow or asset values, a country's export revenues. The way things are working now is that credit is created where production is weak, e.g. U.S. trade deficits, LDC debts, whereas creditor countries, such as Japan and Germany, are enjoying record export surpluses. Exactly the opposite is required for systemic stability; the creditor countries should run trade deficits so debtor countries can achieve the trade surpluses necessary to service their debts.

These considerations suggest that until global debt problems and trade imbalances come under better control, there are risks that international financial problems could emerge. Western governments will react to such problems if and when they appear. Their policy reactions may affect Soviet trade and financial interests. Soviet policy makers should, therefore, have an interest in how such policies are formulated.

B. FINANCIAL CHANGE, INNOVATION AND DEREGULATION

1. Securitization

The emergence of the global debt crisis in 1982–83 has spurred a series of changes in international financial markets that has altered the nature of international banking in fundamental ways. For a decade prior to the debt crisis the syndicated loan market among banks in London was a primary channel for recycling liquidity to borrowers in international capital markets, accounting for over 50 percent of credits arranged. Syndicates of banks would underwrite medium and long-term loans for borrowers; these loans would then be held in the portfolios of the banks.

As a result of the debt crisis and other structural changes in financial markets, this syndicated market has declined markedly and now accounts for only about 15 percent of international borrowing.[1] Banks have cut back sharply on lending to developing countries, and for loans to still creditworthy countries, a trend toward securitization has emerged. The essence of securitization is that the loan instrument is in a form that allows the credit to be readily sold by the underwriting bank. Typically, such an instrument would be a bond or short-term note, but any bank loan in saleable form would also qualify. Purchasers of these securities in-

[1] Morgan Guaranty Trust Co., *World Financial Markets*, December 1986, p. 2.

clude other banks, corporations, insurance companies, pension funds and official institutions.

Rather than concentrating on underwriting syndications and holding long-term loans in their portfolios, many major international banks are now seeking to profit from underwriting securities which are sold to investors and from trading of these securities still held in the banks' portfolios. Clearly, for a security to be saleable there must be a market willing to accept the credit risk of the borrower. In practical terms, demand in this market is limited to "investment grade" securities (rated BBB or higher); for the most part, these are developed industrial countries or "blue chip" multinational corporations (most rated AA or AAA). Although some lesser quality credits have been underwritten successfully, the market for such securities is rather limited.

The trend toward securitization has important implications for future Soviet borrowing strategies. Securitization opens up a new, and potentially large source of liquidity for the Soviet Union. Diversifying the source of borrowing to non-bank investors adds greater stability to the potential supply of capital, thus increasing policy flexibility as well as reducing the overall cost of financing. Diversifying financing sources also reduces the prospects that credit leverage applied by the United States could be effective.

Soviet policy makers, however, also likely see some disadvantages to these developments. The Soviet Foreign Trade Bank, for example, has always been reluctant to allow its promissory notes to trade in western markets. Holders of such notes—which are typically suppliers credits with the guarantee (aval) of the Foreign Trade Bank—cannot sell these notes without permission from the Foreign Trade Bank. These restrictions act to limit the volume of marketable Soviet paper on offer in the West. The purpose of the restrictions seems derived from a desire to influence quoted prices for such paper (by restricting supply) in order to protect its position in the quality end of the market. Another purpose may be to segment the bank market from the suppliers credit market, thus forcing banks interested in acquiring Soviet assets to deal directly with Moscow rather than with their customers with whom they might otherwise refinance such Soviet suppliers credits.

Securitization implies the creation of active and uniform primary and secondary markets where potential creditors—banks, suppliers, or investors—could examine characteristics of new and seasoned securities by pushing a button on a Reuters screen. These creditors could evaluate interest rate spread differentials over similar maturity U.S. Treasury issues or other sovereign issues, and then act on their judgments of the risk/reward relationships. The issue is whether Soviet leaders will allow and even encourage such a market to develop for Soviet securities.

Past experience suggests that Soviet leaders have always been uncomfortable relying on financial markets for something as vital to their security as foreign exchange. In addition, one wonders whether Soviet officials will be concerned with the open nature of these markets—what if Soviet securities traded at discounts similar to those observed for AA-rated borrowers such as Denmark or New Zealand, rather than for AAA-rated borrowers such as France?

Whether they will change their thinking in the present instance probably depends on the scope of the benefits they might hope to gain by tapping into the markets opened up by the trend toward securitization. Most likely, they will test the appetite of the market for Soviet securities before making a major commitment to securitization. And before this happens, there will be pressure to settle on outstanding defaulted Czarist bonds in order to improve the country's image among potential investors. A settlement was reached in August 1986 with British authorities on behalf of British bondholders; this suggests that other outstanding claims may be negotiated.

2. Financial Innovation

The new financial instruments emerging in the marketplace may be grouped into three general categories. The first group includes instruments for managing interest rate and currency risk, such as coupon and currency swaps, interest rate futures and options. These products allow a borrower to reduce interest rate mismatches between short-term assets and liabilities (e.g. interest due may be determined with reference to the six-month rate but interest received may be fixed with reference to the one or twelve-month rate) and to restructure liabilities to achieve a desired mix of fixed or floating rate debt and a desired mix of debt by currency.

A second group includes products giving borrowers increased flexibility in raising needed funds. Examples would include note issuance facilities (NIF's), Eurocommercial paper, and medium-term Euronote facilities. NIF's involve medium-term commitments from a group of underwriting banks to sell in the market a given quantity of the borrower's short-term notes, or to purchase the notes themselves if the paper fails to sell. The market for Eurocommercial paper is similar, but the banks place the paper on a "best efforts" basis on request from the borrower, without a commitment to minimum quantities that will be placed. Euronotes are similar to Eurocommercial paper in being continuously offered, but for longer periods.

The third category of new products includes instruments tailored for specific needs of the investor. Examples include zero coupon bonds, dual currency bonds, and bonds with warrants or puts. Asset-backed or collateralized securities bridge two categories since they aid borrowers by liquifying hard-to-finance assets, while giving the investor lower risk.

The use of the new instruments in groups one and three pose no fundamental policy issues for Soviet decision makers. The use of hedging instruments such as swaps is an issue of convenience and lower cost. There are no barriers to increased Soviet activity in this area other than learning how to employ these instruments to best advantage. The prospects for group three innovations are not relevant at this time, since no bonds of any kind have been issued.

The primary issue facing Soviet decision makers, therefore, is whether to expand activities into the new instruments represented by group two. A decision to expand the use of short-term facilities such as NIF's and Eurocommercial paper would complement a commitment to the securitization of international borrowing discussed in the above section of this paper.

3. Deregulation and Privatization

International financial innovation is having a significant influence on decisions by many industrial countries to reduce the role of the state in regulating domestic financial markets and in managing state-owned companies. Recent advances in communications technology have made many regulations designed to insulate domestic markets obsolete. Governments are deregulating and privatizing in order not to lose competitiveness in trade and financial matters to those countries that have already taken such steps.

The message for Soviet planners is a simple one. Domestic economic reform, including the integration of the new technologies in the information processing and communications fields into economic management, is an essential element of any strategy to capitalize on the benefits offered by the evolving global financial market. The fact that traditional "statist" countries such as France, Spain and Italy are abandoning centuries of tight central control of domestic financial activities and foreign exchange flows in favor of greater integration into international financial markets cannot have passed unnoticed in Moscow. What Soviet experts make of these trends, though, is not known.

An indirect result of increasing global financial integration that may also concern Moscow is the growing consensus on the need for coordination of economic policy among the major industrial countries. Although international policy coordination is more rhetoric than fact at the moment, continuing trade frictions may in the future lead to more serious and effective coordination of policy than evident so far. Such developments could prove a disadvantage to the Soviet Union and other Eastern European countries. Even if current trends toward the emergence of a strong European, Deutschemark-based currency bloc continue—as seems probable—these countries are likely to be focused primarily on the two other poles of this tripartite system, i.e. Japan and the United States, and not on Eastern Europe. Soviet leaders, therefore, should not take much consolation in the West's current economic problems, since the way these problems are managed may act to limit Soviet access to western markets.

C. NEW POLICY INITIATIVES IN SOCIALIST COUNTRIES

New policy initiatives in several other socialist countries are relevant to Soviet decisions on international financial policy. The two countries most active in this field are China and Hungary.

In both countries decisions to join the International Monetary Fund and the World Bank marked the initial step in the process of changing foreign financial policy. The PRC joined these institutions in 1980 (taking over the seat previously occupied by the Republic of China) and Hungary followed in 1982. Hungary has actively utilized short-term financial support from the IMF since membership; its use of Fund credit totaled $1.0 billion at the end of October 1986, representing about 7 percent of the country's total foreign indebtedness. China has also used Fund resources, but less actively. China drew down an IMF standby credit of $550 million in early 1981; this sum was repaid in mid-1983 and no further drawings have been made to date. Both countries have actively used World Bank loans. Since joining the World Bank, loan commitments have

totaled $4.2 billion for China (including IDA commitments) and $1.2 billion for Hungary.[2]

Both countries have been active issuers of securities in recent years. Hungary has focused primarily on the short-term note market. China's experience seems even more relevant to future Soviet policy, particularly its success in tapping the Japanese capital market. During the first half of 1986, for example, China issued various securities valued at over $1.3 billion; $1.0 billion of this total represented yen denominated securities issued in Tokyo.[3]

China also faces the issue of pre-regime defaulted securities still outstanding in the United States and the United Kingdom. A settlement of these claims has been discussed for some time without resolution. Despite this fact, China issued $200 million in floating rate notes in June 1986 in Frankfurt. The British government indicated its displeasure with the participation of several British investment banks in the deal by excluding them from a major borrowing by the U.K. Treasury which was arranged several months later. The Soviet-British agreement to settle defaulted bonds in the United Kingdom was reached in August 1986.

China's success in attracting foreign investment capital is also noteworthy. Chinese authorities announced recently that 7,300 foreign direct investments totaling $5.9 billion have been approved since 1980, most located in special foreign enterprise zones.[4] Although the effective transfer of foreign capital is probably substantially less than the total authorized, the numbers are impressive.

China and Hungary have also supplemented their foreign initiatives with reforms of their domestic banking systems. Hungary has so far authorized the domestic operations of two joint-venture banks and at the beginning of 1987 a decentralization of the state-owned banks was introduced.[5] China has also begun to revamp its domestic banking system to permit increased competition. In December 1986, the Bank of Communications was reestablished in Shanghai with authorization to engage in a full range of domestic and foreign operations—the five other domestic banks each specializes in a particular activity. The domestic offices of the bank were taken over by the People's Bank shortly after the revolution, but the Hong Kong branch continued to operate. The new Bank of Communications plans to raise capital through stock issues—50 percent is expected to be allocated to the Peking government, 25 percent to the Shanghai government, 20 percent to Shanghai enterprises and 5 percent to individuals.[6]

The pattern of new financial initiatives in China and Hungary reflects three components:

(1) membership in the IMF and World Bank;

(2) placement of securities as part of an overall borrowing program;

(3) encouragement of foreign investment;

(4) reform and decentralization of domestic banking system.

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[2] Data are from official IMF and World Bank sources.
[3] *The Banker* (London), August 1986, p. 19.
[4] *Asian Wall Street Journal*, December 16, 1986, p. 15.
[5] "The Hungarian Banking Reform," *Public Finance in Hungary*, No. 33 (Budapest: Ministry of Finance, October 1986).
[6] *Asian Wall Street Journal*, November 18, 1986, p. 1.

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V. Policy Options—An Evaluation

A. MEMBERSHIP IN INTERNATIONAL INSTITUTIONS

A group of American economists attending an economic symposium in Moscow in June 1986 reported that their Soviet hosts expressed "serious interest" in becoming affiliated in some way with the IMF, the World Bank and GATT.[7] In reporting on the Moscow discussions, The Wall Street Journal suggested that Soviet interest was motivated by a new strategy "to tap international credit markets for large amounts in coming years." [8]

The above analysis of external developments suggests that the priority concern of Soviet leaders at this time is probably trade, rather than finance. The costs of nonmembership in GATT, which deals with multilateral trade issues, could be very real in terms of loss of export market shares, given the climate of increased trade friction in the West and the apparent Soviet desire to diversify exports away from primary commodities into manufactures where multilateral agreements are significant. In the financial area, Soviet planners face new opportunities, whose potential benefits are still not well understood outside of a small circle of Soviet financial experts. In any case, closer integration with western financial markets will only cause repayment problems unless the trade issues are also managed satisfactorily. Soviet affiliation with GATT as an observer or associate member is, therefore, probably a top priority. A second priority may be to encourage closer ties between the EEC and Comecon, perhaps including formal diplomatic recognition.[9]

Why would Soviet leaders, then, consider joining the IMF and World Bank? Soviet membership in these institutions does not promise access to the credit resources of these institutions. IMF membership would qualify the Soviet Union for borrowing from the Fund's general resources, but Soviet leaders would be very reluctant to draw on these resources, not only for prestige reasons, but also for concern about policy conditionality which would accompany any Fund standby. And the Soviet Union could not qualify for World Bank loans, since Soviet per capita income exceeds the Bank's current guidelines.

One reason given for such interest is that membership would improve the Soviet Union's abiltity to tap private credit markets.[10] If Soviet credit requirements rise in coming years, private lenders are not likely to draw much comfort from the fact that the Soviet

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[7] An excellent report on these discussions was published by Paul Marer in "Growing Soviet International Economic Isolation and Severe Problems Ahead in the Foreign Trade Sector Prompt Top Soviet Economists to Advocate Membership in the IMF, World Bank and GATT," *PlanEcon Report*, No. 31, July 31, 1986. A comprehensive survey of views of socialist countries on these institutions may be found in "International Monetary Reform and the Socialist Countries," in United Nations, *Supplement to World Economic Survey: 1985–86* (New York, 1986), pp. 1–27.

[8] Witcher, S. Karene, "Soviets Consider Joining IMF, World Bank," *Wall Street Journal*, August 18, 1986, p. 32.

[9] "EC, Soviet-Led Trade Bloc Seek Closer Relations," *International Herald Tribune*, September 23, 1986, p. 1.

[10] Statement attributed to Jan Vanous, research director of PlanEcon Inc., a leading specialist on Soviet and East European foreign trade in Witcher, *op. cit.*

Union has unused borrowing lines with the IMF. Thus, the Hungarian success in using Fund resources—which acted to boost private lenders' confidence in Hungary—is not really relevant to the Soviet case. And if private lenders think the Soviet Union could benefit from economic policy guidance from the IMF, they are unlikely to lend the country much money in the first place.

The most persuasive arguments for Soviet leaders in favor of IMF/World Bank membership are the same as those in favor of GATT membership—the Soviet Union would derive benefits from participation in institutions whose decisions affect Soviet vested interests. Since these interests appear to center on trade rather than financial issues at this time, it is probable that membership in the IMF/World bank is a secondary priority, if at all for Soviet leaders. It is possible, though that the Soviet Union would seek some sort of "observer" status at the IMF, similar in certain respects to Switzerland, which is not a member but which cooperates with the Fund in various ways.

This conclusion is supported by a consideration of costs the Soviet side would likely have to incur in negotiating membership in the respective international organizations. The central issue in accession to GATT is reciprocity, given the centralized control of foreign trade in the Soviet Union. No issue is simple when dealing with the Soviet Union, but the same issue has faced other socialist planned economies, and compromises have been worked out; the Soviet Union and East Germany are the only major socialist countries still not affiliated with GATT. This suggests that the Soviet Union will seek some formula for observer status, rather than full membership.

When it comes to IMF membership, the cost-benefit calculus leans more to the cost side than in the case of GATT. Not only are the benefits less tangible, the costs of IMF membership are more daunting. Soviet leaders are likely to balk at the requirement to release essential economic information, such as domestic budgetary data and figures on foreign debt and reserves. And the political difficulties of negotiating a quota acceptable to Soviet leaders poses a fundamental stumbling block. While the Soviet Union is able to offer limited concessions in the trade area to western countries, all it has to offer the West in the realm of finance are data now classified as state secrets. It is doubtful that such concessions would be offered. These considerations suggest that although Soviet leaders may be considering affiliation with the IMF, they are unlikely to seek membership any time soon.

B. INCREASED RELIANCE ON FINANCIAL MARKET INNOVATIONS

IMF membership for China and Hungary was complementary to their new policy initiatives seeking increased involvement in the global trend toward securitization of borrowing. The conclusion of the above paragraph suggests that Soviet policy may seek increased involvement in western securities markets without the benefit of IMF membership.

During 1986 the Soviet Union took several steps to pave the way for its first major foray into western securities markets. At the time of the settlement of outstanding bond claims with the United

Kingdom in August, the Soviet Foreign Trade Bank participated as an underwriter at the co-manager level in a 15 billion yen Eurobond issue for the Nordic Investment Bank.[11] The Foreign Trade Bank also arranged an innovative five year 100 million sterling bankers acceptance facility with British banks.[12] Since bankers acceptances are designed to finance physical trade, they differ from short-term securities, which are purely financial in nature. These transactions have spurred speculation that a Soviet issue, either a bond or NIF, is imminent. One source reported that Moscow was "wall-to-wall" bankers, as prominent investment banks arrived with financing offers.[13]

The issue, therefore, seems not whether Soviet securities will be issued, but when and how Soviet bankers will open up this market. A related question concerns the volume of securities that could be placed in the market as it develops in the future.

If past performance is a guide, Soviet bankers will approach the securities markets cautiously, timing borrowings so as to maintain sufficient competitive pressures among prospective underwriters to assure the finest terms on each offering. Given the development of global dollar surpluses, a top priority will clearly be the tapping of the Japanese capital market, particularly for bond issues. Another priority is likely to be the development of the London short-term Euronote market, since costs of such borrowings are likely to be less than the cost of interbank borrowings through Soviet subsidiary banks in the West.

The volume of securities likely to be issued by the Soviet Union in the coming 3–5 years will depend primarily on the willingness of Soviet planners to foster the development of a market for Soviet securities and on the reception that such securities find among investors.

The recent sterling acceptance facility, where a tender panel of banks will bid competitively to accept bills below an agreed maximum commission rate, indicates Soviet accommodation with market practice. At the same time, Soviet bankers have continued to line up traditional types of financing. In November 1986, the Soviet Foreign Trade Bank arranged a $300 million syndicated credit with a group of banks led by Banque Nationale de Paris, as well as a $500 million open credit line with the official Italian credit agency, the first such facility in ten years.[14] These developments indicate that moves to develop a market for Soviet securities may be slow in coming.

The potential demand for Soviet securities depends on both economic and non-economic factors. The changes in bank strategies described earlier suggest that a number of banks will be primarily interested in underwriting and trading Soviet securities rather than holding such securities in their portfolios. Other potential investors may worry about perceived political risks or unresolved problems such as Soviet attitudes toward the remaining defaulted Czarist bonds, or—for Japanese investors—the long-standing dis-

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[11] *Institutional Investor* (International Edition), September 1986, p. 33.
[12] *Financial Times*, August 8, 1986, p. 28.
[13] *Institutional Investor, op cit.*
[14] *Financial Times*, October 20, 1986, p. 20 and November 27, 1986, p. 23.

pute over the sovereignty of the Northern Territories between Japan and the Soviet Union.

The lack of economic information will also deter many potential investors. In Germany, for example, the disclosure of economic information is required for a stock exchange listing; without a listing, securities cannot be offered to domestic investors. Other investors do not invest in securities that have not received a rating by a major rating agency. The lack of information prevents such a rating. Although estimates of the Soviet balance of payments and debt are available, the quality of the data used to produce such estimates is subject to question. Banking statistics published by the Bank for International Settlements, for example, do not include securities held by banks in several major countries (e.g. Germany) or off-balance sheet exposure (e.g. swaps); securities and private placements held by non-banks are not surveyed at all.[15] This is not an issue currently, but it will be in the future.

More importantly, the existence of Soviet subsidiary banks in the West makes the determination of Soviet assets or liabilities difficult. The Foreign Trade Bank, for example, might refinance suppliers credits extended by Moscow to third world countries with its subsidiary banks in the West. Such a refinancing would create a Soviet foreign exchange asset, even though the underlying asset might not be liquid.[16] On the other hand, Soviet gold reserves are generally not included in estimates of foreign reserves, given the lack of data. We simply do not know enough about the size or composition of Soviet assets or liabilities. A proper assessment of the Soviet balance of payments position requires a consolidated international balance sheet for the Soviet Union, similar to the data available for western countries.

These considerations suggest that the growth of a market for Soviet securities will be slow to develop. A decision by Soviet leaders to release essential balance of payments data could spur the development of such a market, provided, of course, that western investors are happy with what the data reveal. It is unlikely that potential western investors will be fully satisfied with western estimates of the Soviet foreign exchange position, given the shortcomings of data on which these estimates are based.

C. FOREIGN TRADE REFORMS AND FOREIGN FINANCIAL POLICY

In a move to improve the efficiency of the foreign trade system within the Soviet Union, Soviet leaders announced a decentralization of the traditional foreign trade monopoly. Beginning January 1, 1987, 21 ministries and some 70 major enterprises have authority

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[15] On the need to improve international financial statistics see Bank for International Settlements, *Recent Innovations in International Banking*, Chapter 11, "Impact of Innovation on Financial Statements and Statistical Reporting," (Basel, April 1986).

[16] Other examples of how the existence of Soviet subsidiary banks in the West may misstate Soviet assets are cited by Roger Robinson in "Soviet Cash In Western Banks," *National Interest*, Summer 1986, pp. 37–44. One western estimation of Soviet net debt chooses to ignore Soviet supplier debt and supplier credit on the grounds that no bias is introduced if both are excluded. The problem with this is that bias may be introduced if such assets are refinanced with Soviet subsidiary banks or if the quality of the assets is substantially worse than the quality of Soviet liabilities. "Soviet Union: Fifty Billion Dollar Plus Gross Hard-Currency Debt by 1990 and Stagnant Quantity of Hard-Currency Imports Over the Next Five Years a Distinct Prospect," *Plan Econ Trade and Finance Review*, Summer 1986, p. 5.

to import and export on their own account and to maintain foreign currency bank accounts. In addition, a new Foreign Economic Relations Commission has been set up for the purpose of formulating and coordinating Soviet foreign economic policy. The Commission includes 12 members, representing key Soviet organizations and ministries at the minister or deputy minister level. Both the Minister of Finance and the Chairman of the Foreign Trade Bank are included. In a related move, Soviet authorities have indicated to western firms their intention to introduce legislation permitting joint ventures within the Soviet Union by mid-1987.[17]

The new rules on trade will eliminate existing foreign trade organizations as middlemen for the enterprises concerned. This should facilitate trade transactions, particularly for exports. At the same time, it appears that overall responsibility for foreign trade and financial policy will remain with the Ministries of Foreign Trade and Finance, respectively.

It is in this regard that the role of the Foreign Economic Relations Commission is unclear. Presumably, these two ministries will recommend policies to the Commission and be responsible for implementing its policy decisions. Although the Commission will provide a broader context for the discussion of key issues, it is not clear that this will really change anything, especially in the field of foreign financial relations. Most financial issues are complicated, requiring specialized knowledge for full understanding. Unless the other representatives on the Commission act to develop such information and expertise and are able to present their views effectively, the Ministry of Finance and the Foreign Trade Bank will continue to dominate decisions in these areas.

The same is true with regard to the decentralization of trade authority. The firms receiving new trade powers would need to develop financial specialists able to access the current data on western financial markets and to evaluate the pros and cons of financing alternatives, and then they need to have the ability to act on their judgments. The new reform does not go this far, particularly in regard to the freedom for these firms in financing matters.

The potential contribution of joint ventures is difficult to assess until regulations are adopted, but one may question whether such ventures add much to other forms of industrial cooperation which have been practiced for years. The basic problem of such ventures is the difficulty of integrating them into the domestic economic system of planning and pricing; the foreign trade reform does not address such issues. The Chinese success with joint ventures derives heavily from the possibility of utilizing Hong Kong, and has only limited relevance for Soviet planners.

Thus, while the new reforms indicate serious efforts to streamline the foreign trade apparatus, it is doubtful that they will have much relevance to foreign financial policy at this time. The examples of China and Hungary suggest that reforms in the financial field require a decentralization of the bank monopoly and the creation of a more competitive banking system. It is only at this point that financial experts in the enterprises have a role to play in deci-

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[17] Kempe, Frederick, "Moscow Easing Laws Governing Foreign Trade," *Wall Street Journal*, September 12, 1986, p. 3.

sion making. Both of these countries have begun a move toward such a decentralization, but only after a number of years of experience with reform in the trade area. Prospects for a decentralization of the Soviet banking system any time soon are not high.

VI. Conclusions

Although faced with major dilemmas in decisions concerning resource allocation at home, Soviet leaders will likely opt for foreign financial policies that reflect an evolution in past policies, rather than radical changes. Borrowings will continue to emphaize traditional sources, such as official credit from western governments. But a diversification in financing is likely, in order to benefit from the opportunities offered by the financial revolution in western markets. Future financial policy will be constrained by Soviet judgments about the instabilities in western economies and limited prospects for Soviet exports to the area. The priority of trade problems over financial ones also suggest that Soviet leaders will not feel compelled to compromise on issues relating to IMF membership or information disclosure. The integration of the Soviet Union into western securities markets will, therefore, be slow in developing.

For Soviet leaders the fundamental challenge associated with foreign financing is how to use such foreign resources more efficiently, not whether to borrow more. A more active utilization of western financial innovations promises a more stable source of borrowing on better terms, but this does not address the efficiency question. The productivity of foreign capital in the domestic economy remains far below potential. For this reason, the issue of how its contribution can be raised, e.g., by economic reform, is surely a higher priority for the Soviet leadership than increased participation in western financial markets.

COMMENTARY

By Alec Nove*

There is as yet not a coherent, integrated reform programme. Reporting on a high level meeting of the relevant section of the Academy of Sciences, Aganbegyan said: "The economic section does not yet have proposals for an all inclusive (*tselostnoi*) system of management which would constitute the basis for a radical economic reform . . . The question of where next to go, as far as the economic mechanism is concerned, still remains open".[1] Reports reach us of commissions and committees, official and academic, preparing the "radical" change which Gorbachev has been proposing, but proposing still in somewhat general terms. (One such, "the Commission for the perfecting of administration, planning and the economic mechanism", is referred to in *Ekonomicheskaya gazeta*, No. 43, 1986, p. 7, to give an example). The measures so far taken (such as the decrees on agriculture, on light industry and on foreign trade) do not constitute a radical reform. The additional powers so far assigned to industrial associations and enterprises do not go very far either, though the need for substantially increased autonomy is recognized. We lack clear evidence as to just what new decrees are in draft, or might see the light of day by the end of the decade. It must never be forgotten that a radical restructuring of the system is a highly complex operation, and does genuinely require careful preparation. The fact that reforms so far have been cautious and partial is therefore not proof that radical measures have been rejected or shelved.

Complicating our assessment is the fact that Soviet economists have been expressing widely divergent views. There are two quite fundamental elements which help us to define how "radical" the reform is: one concerns *trade in means of production*, and the other related to *prices*. Both are intimately linked with enterprised autonomy, and this for the following reasons. Firstly, orders from above as to what to produce (i.e. "directive" production plans) are an integral part of the system of administered material allocation, and also vice versa: if the bulk of the inputs are subject to allocation by planners, the bulk of the output must be administered too, since so much of it is used as inputs. Secondly, if enterprises and the trade organs are to be free to choose from whom and what to purchase, then clearly the product mix must be determined through negotiation with customers, with freedom to choose one's supplier granted to the customer. Thirdly, the proposal that enterprises stand on their own financial feet requires that what they are called upon to do is not loss-making (or that, if it is, that they have

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[1] *Voprosy ekonomiki*, No. 6, 1986, p. 111.

some legal rights to compensation). Fourthly, freedom to choose inputs and to determine the product mix implies an active role for prices, and so a radical restructuring of the price mechanism. Finally, the idea that the re-equipment and modernization of enterprises be largely financed by them (out of retained profits and/or bank credits) requires that they be free to purchase the needed equipment, and this implies *trade* (not central allocation) of means of production.

Yet on these issues one hears many discordant voices.

Should enterprises be free to choose their own suppliers? Should there be trade in means of production? Yes, of course, say Borozdin,[2] M. Bronshtein [3] and Latsis.[4] No, argue Fel'zenbaum [5] and Rodin.[6] Some like Lokshin [7] would confine such choice to enterprises making consumers' goods.

Should the product mix be determined by the producers, in negotiations with customers, influenced by considerations of price and profit? No, argues Komin.[8] He actually states that "evidently (*sic!*) if profitability were to determine what is produced, this would be bad". Rodin likewise opposes "any attempt to grant to the actual producer the right to determine the product mix as it could lead to uncontrolled spontaneity (*stikhiinost*) in the economy". A contrary view is emphatically expressed by, for example, Petrov, who argues that "economic levers would determine the detailed product mix," [9] and also by Latsis: only the user can judge the results, the quality, the appropriate price, of productive activitity. ". . . The critical path must lead to wholesale trade in means of production". Detailed planning of assortment in physical units cannot possibly work.

Should prices be flexible? Yes, argued Petrov. Prices should reflect "market conditions" (*rynochnuyu konyunkturu*). Borozdin wants price fixing by the centre confined "only to structure-determining types of products", the rest to be sold at negotiated prices, with, as already mentioned, free choice of partners. Anchishkin advocates "prices settled by negotiation", subject to some upper limit.[10] Whereas Komin believes in stable prices, "for a whole quinquennium", and Rodin opposes the use of value indicators. The former head of the prices committee, Glushkov, was a known opponent of supply-and-demand-balancing prices, but he has been retired, so the reformers may have the upper hand, with Gorbachev publicly supporting a revision of the price mechanism, though without clearly stating just what form this would take. Gorbachev and a number of other critics concentrate their fire, rightly, on the fact that prices passively reflect costs, that the existing system can have the perverse effect of encouraging enterprises to choose dearer inputs. Obviously, so long as (for example) construction enterprises fulfill plans in millions of roubles of expenditure, and are

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[2] *Ekonomicheskaya gazeta*, No. 21, 1986, p. 7.
[3] *Voprosy ekonomiki*, No. 2, 1986, p. 81.
[4] *Kommunist*, No. 13, 1986, p. 39.
[5] *Voprosy ekonomiki*, No. 3, 1986, p. 4.
[6] *Planovoye Khozyaistvo*, No. 1, 1986, pp. 16–17.
[7] *Voprosy ekonomiki*, No. 2, 1986, p. 46.
[8] *Ekonomicheskaya gazeta*, No. 23, 1986, p. 6.
[9] *EKO, No. 1, 1986, pp. 21–31.*
[10] *Voprosy ekonomiki*, No. 9, 1986, p. 7.

penalized for underspending, they will actively seek dearer materials and be reluctant to switch to cheaper ones. Under such circumstances a rise in price of any producer's goods will not have the effect of reducing demand for it, unless and until enterprise profitability, and not plan-fulfillment in value terms, becomes the predominant success indicators. Similarly, if plans are expressed in tons, economy of metal (reduction in weight) will be actively discouraged, and so supplementary plan targets will be needed to compel or reward economy of materials. This in turn causes the multiplication of the number of compulsory indicators, and conflicts with the needed enterprise autonomy and with flexibility in adjusting the product mix to user requirements. In other words, reform of the price mechanism is intimately linked with the proposal of "full *khozraschyot*", and with a fundamental change in the nature of the planning system itself. To cite Latsis, the problem is not the imperfection of this or that plan indicator, but their very existence as targets which are imposed from above (*razverstka sverkhu*) (*Kommunist*, No. 13, 1986, p. 33). Other disagree.

As far as consumers' goods are concerned, reformers argue not only for the need to relate retail prices more closely to supply-and-demand conditions, but also to establish a direct link between these prices and those paid to the producers. Thus Shatalin: "It must be particularly stressed that retail prices now have no influence whatever on production . . . , since the producer lives exclusively in a world of wholesale prices, which are in no way linked with retail ones".[11]

Others direct their attention to prices of new machinery and to the problem of linking them with effectiveness in use. All agree that what should be produced should reflect user requirements (use-value), but whereas some believe that these can and should be incorporated in clearly-defined quantitative disaggregated plan targets, others assert (rightly!) that this is impossible, that only the user's judgement, and free choice, can determine the value-in-use of a consumers' good or a machine.

Several, such as Kirichenko[12] combine radical-reform proposals with a plea to differentiate between sectors. This is wise. The optimal level of decision-making in (say) the oil and steel industries is not the same as for textiles, instruments, sausages.

It is my impression that the more influential and intelligent economists take the more radical line on these issues. Recent senior appointments to economic institutes, e.g., of Abalkin and Anchiskhin, and the role of Aganbegyan and of Zaslavskaya, can be cited in support. However, divergent views continue to be expressed. The more hard-line view surely found expression in the decree outlawing so-called "unearned incomes", published on 28 May 1986. Interestingly, Zaslavaskaya, in a paper presented to the Vienna congress of the European Economic Association, advocated not only cooperatives of many kinds but also small-scale private enterprise too.[13] More liberal ideas found expression in the recent

[11] *Ekonomicheskaya gazeta*, No. 20, 1986, p. 6.
[12] *Kommunist*, No. 13, 1986, p. 13.
[13] Social factors of speeding up the development of Soviet society", Novosibirsk, 1986 (mimeo).

law on "individual labour activity" (*Pravda*, 21 November 1986), though we do not yet know how this is to be interpreted in practice. But enough has been said to show how different are the views emanating from the Soviet economic profession.

Open disagreement can have three interpretations. One is simply that economists feel free to say what they think, and, like in other countries, do not agree. Another is that the leadership has not made up its mind what to do, and is deliberately calling out to economists to make proposals. Finally, there may be divergent views among the leadership, and some support one or other group of economists. These three explanations are not necessarily mutually exclusive.

As I see it the outline of Gorbachev's programme contains some potentially contradictory elements. A principal one is the simultaneous pursuit of *uskoreniye* (growth acceleration) and *perestroika* (restructuring, i.e., reform). However, the short-run effect of publishing plans full of quantitative growth targets, if past experience is to be any guide, is bound to lead to pressure down the line to fulfill these targets, to the detriment of quality or attention to the precise requirements of the customer. *Uskoreniye* may well cause strain, and ensure the continuance of shortages (of materials, energy, labour, etc.), which would make impossible the abandonment of material allocation (rationing) of inputs and also stand in the way of relaxing price controls. Indeed Gorbachev himself referred to the danger (*Pravda*, 16 October 1986).

There is an interesting remark by S. Zhuravlev, [14] which indirectly highlights this dilemma. He pointed out that, "a 4 percent annual growth rate in the next period could be equal in its real content, as computations show, to about 5.4–5.8 percent growth in national income in past years", if the distortions and "negative tendencies" of the past were eliminated. This is, of course, an indirect way of indicating the estimated scope of past distortions (i.e., a claimed 5.4–5.8 percent was really 4 percent), and leads to two conclusions. One is that the real acceleration would be bigger than it looks if the distortions are to be ended, and, secondly, efforts to fulfill these more ambitious growth targets will set up pressures not to eliminate the distortions.

Another problem relates to wages. Is the level of wage payments to depend on:

(a) The financial results of the enterprise?
(b) Productivity increases?
(c) Brigade or other small-group contract? or
(d) Some minimum tariff rate plus a bonus calculated in one or other of the above ways?

All this still requires to be sorted out. Evidently in Russia as elsewhere, a rise in labour productivity, or the timely completion of a task, can coexist with a profit-and-loss account in deficit, whatever the basis on which prices are determined.

It is correct to note that the new decree on wages and salaries envisages a wider differential between more efficient and less efficient workers. Also it provides for a much-needed boost for salaries

[14] *Ekonomicheskaya gazeta*, No. 24, 1986, p. 4.

of engineers and technologists, which have fallen behind those of skilled workers, with consequences for the morale and the quality of recruitment. Indeed among the reasons given for poor-quality of investment projects is the poor pay of those working in project-making organizations.[15] However, it is not yet clear how the new system of wage payments will be related to the financial position of enterprises.

A few additional comments, touching questions raised by Hardt-Kaufman and by Berliner. Indeed, "they need an 'information revolution' ", and they know it. It will be a paradox if it turns out that computerization will not (as some believed) "save" centralized planning, but rather it will provide a basis for necessary decentralization based on a wide circulation of the needed information. Such circulation is now impeded by the obsession with secrecy and by departmental barriers. Also the recent decree on foreign trade is designed to make possible closer contact between Soviet management and foreign markets, with implications for the wider circulation of information of many kinds. Though it is unfortunate that, coincidentally, the collapse of the oil price is compelling the USSR to reduce rather than to increase its import dependence, (unfortunate, that is, from the standpoint of those desiring the USSR to have a more open economy).

Berliner seems to be not altogether correct in saying that Gorbachev "blames the managers for the deficiencies of the system". He does assign some of the responsibility to them, but he does explicitly recognize that the system both frustrates them (by "petty tutelage", unreliable supplies, frequent changes of plan) and provides irrational incentives (e.g., to use dearer inputs, or to conceal production potential). Indeed Berliner himself recognizes this, but still insists that Gorbachev thinks that "the problem is with people." In part it is. The *nomenklatura* system had been misused for too long to appoint obedient mediocrities. Yet how can we say, on the evidence, that "Gorbachev turns to radical reform not with enthusiasm", when he surely knows that the system must be changed? Whether he will succeed in changing it is another question.

Berliner also asserts both that "the ministry will be given more authority", and that "it must cease involving itself in the internal affairs of enterprises". Can both these statements be right? It is my impression (echoing that of Zaslavskaya) that reform plans would reduce ministerial powers.

I agree with much of Berliner's argument, but his interpretation of "end result" did surprise me. Yes, management should not be rewarded for "intermediate goals", but surely the problem is that many enterprises provide intermediate *goods and services*. Rewarding them for fulfilling output plans incites to waste and penalizes economy. Two examples: transport targets in ton-kilometres encourage unnecessarily long hauls, "chemicalization" enterprises serving agriculture had plans in money spent and so spent the money; and the same was true of construction enterprises, stimulating waste and penalizing the economy. The solution is, firstly, not to fix quantitative plan-targets for intermediate products, and

[15] See for instance Yartsev and Sheniman, in *EKO*, No. 10, 1985.

secondly, to give real powers to the *customers*. Which requires overcoming the notorious *defitsit*, i.e., shortages.

Berliner is right to point to the danger that "normatives" will become a source of inflexibility. I would add another danger: that through them certain traditional plan targets, supposedly to be abolished, will be resurrected. Take his example: a "norm" of 20 rubles of wage for every 100 rubles of output. So there would be an incentive to "inflate" this aggregate, for instance by avoiding making cheaper variants of the product.

It does not follow from the principle of cost-based prices that "roughly half of all industrial output must be produced at a loss", since the average rate of profit over cost is close to 15 percent.[16] In Soviet conditions it would be quite wrong to fix prices at a level which would cover the costs of the least efficient enterprise, which may have costs double or even treble the average. The solution would be to close it down or re-equip it. Also in the West, at any given moment, the least efficient enterprises make losses! Only in "equilibrium" in text books on micro-economics, is this not the case! But I agree with Berliner that the problem of subsidizing loss-making enterprises is unlikely to go away.

Finally, how far will Gorbachev go? We do not know. One possibility, rightly discussed by Berliner (and proposed by some of the reformers) is confining the obligatory plan to a part of output, the rest being subject to free negotiation. Thus Gorbachev's reference to *prodnalog* (tax-in-kind) in the "agricultural" part of his speech to the 27th Congress implies just that: farms should be free to dispose of a major (*the* major?) part of their output, state-imposed exactions taking only a minority share in it. The same would happen to various industries. Thus a machinery enterprise could have imposed upon it deliveries to the army and to a few top-priority investment projects, leaving (say) half of its output for free trade in means of production. While for consumers' goods the "free" proportion could be much greater. Oddly enough, as Berliner observes, "market socialism" is still an unacceptable phrase, yet "a socialist market" and its synonym, "commodity-money relations", are by now terms in common use.

The forces of conservatism are very strong in the Soviet Union, and it is far too soon to say how far-reaching, how "radical", the reform wave will be. What is certain is that change is on the agenda, and it will be a fascinatingly interesting task to watch and see what happens in the next few months and years.

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[16] According to the Minister of Finance, in 1985 13 percent of industrial enterprises made losses (*Pravda*, 18 November 1986).

II. ECONOMIC PERFORMANCE

OVERVIEW

By Morris Bornstein*

The papers in this section analyze and evaluate various aspects of the performance of the Soviet economy. The most comprehensive view is an appraisal of the growth of the Soviet national product (GNP) by Laurie Kurtzweg ("Trends in Soviet Economic Performance"). A special and often neglected perspective on the Soviet economy is provided by Gregory Grossman's study of household economic behavior outside the socialist sector ("Roots of Gorbachev's Problems: Private Income and Outlay in the Late 1970s"). Population issues are examined by W. Ward Kingkade ("Demographic Trends in the Soviet Union"). Finally, labor inputs are discussed by Stephen Rapawy ("Labor Force and Employment in the U.S.S.R.").

National Product Growth

Kurtzweg estimates that Soviet GNP grew at an average annual rate of about 2 percent between 1975 and 1985 (although a preliminary calculation indicates a spurt to 4.2 percent in 1986). Her estimated growth rates for GNP differ significantly in absolute terms from Soviet official figures for the growth of "national income" according to the concept of net material product (NMP). The Western concept of GNP includes two important categories excluded from NMP: (1) depreciation and (2) services that do not contribute directly to material production.[1] Soviet NMP figures report higher growth rates than Kurtzweg's GNP estimates, both because of these differences in coverage of economic activity and because of distortions in Soviet statistical measures that exaggerate NMP growth.[2] Nonetheless, Kurtzweg's GNP estimates and Soviet NMP figures show the essentially the same declining trend over the last 20 years.

Kurtzweg's calculations indicate that Soviet economic growth has been achieved primarily from additional inputs of capital and labor, rather than from increases in their productivity. In Soviet terminology, the pattern of growth has been "extensive," rather than "intensive."

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[1] For example, freight transport is included in NMP but passenger transport is excluded from NMP.

[2] For a detailed recent Soviet critique of Soviet growth statistics, see Vasilii Seliunin and Grigorii Khanin, "Lukavaia tsifra" [Cunning figures], *Novyi mir*. no. 2, 1987, pp. 181–201.

In regard to sector of origin, industry is the single most important source of Soviet economic growth. But here also output growth has come chiefly from the application of more capital and more labor, rather than from improvement in their productivity. Agricultural output has grown much more slowly, and has fluctuated much more from year to year because of the weather, than industrial output.

Over the last 20 years, there has been little change in the distribution of GNP by end use. At present, about half of GNP is devoted to consumption, almost a third to investment, and the remainder to military programs and various miscellaneous uses like general government administration, inventory change, and net exports.

Household Economic Behavior

Soviet publications, from which many Western studies (like Kurtzweg's) obtain data, reveal little about what Soviet households earn and spend outside the socialist (i.e., state and cooperative) sectors. Through a questionnaire survey of over 1,000 Soviet emigrant families (comprising over 3,000 people), Grossman and his associates studied Soviet private (i.e., non-socialist) incomes and expenditures in the late 1970's.

The survey found that private incomes from a variety of informal, semilegal, and illegal activities added significant amounts to households' incomes from the socialist sectors. In turn, these incremental incomes generated demand for goods and services from the private sector.

However, as Grossman shows in detail, the importance of households' private incomes varied considerably by region (Armenia vs. Leningrad) and by employment status (full-time workers vs. pensioners).

Thus, such studies of the "second" economy increase our understanding of the extent and character of Soviet production, trade, and consumption activities—and in turn of the reasons for official campaigns against "unjustified" incomes and for new legislation to redefine the scope of legal private economic activity.

Demographic Trends

Because additional labor inputs have been a key factor in Soviet economic growth, a decline in population growth, and therefore in increments to the labor force, is a major cause of the Soviet economic slowdown. Also, over the foreseeable future the Soviet population will acquire a more elderly age distribution as a result of the long-term decline in fertility.

However, as Kingkade explains, population growth rates differ markedly among the regions of the U.S.S.R. Population growth is slight in the European regions, where small families (commonly with one child) are the rule. In contrast, Central Asian couples often have six or more children. Thus, the Central Asian republics accounted for more than a third of total Soviet population growth between 1959 and 1985. This Central Asian "population explosion" has caused serious concern among Soviet policymakers. The utility of the indigenous nationalities of Central Asia as a source of indus-

trial labor, and of military conscripts, is constrained by their rural background, low educational level, and limited knowledge of the Russian language.

In response to these demographic trends, the Soviet regime has adopted various population policy programs examined by Kingkade. Measures to encourage greater fertility include longer maternity leaves, lump-sum payments for the birth of a child, and preference for recently married couples in the allocation of housing. To counteract the decline in life expectancy, the anti-alcoholism campaign and improved health care are being pursued.

Labor Force and Employment

With a given population size, age-sex structure, and geographical distribution during a particular period, the task of labor force planners is to use the available labor resources to achieve state plans.

In the U.S.S.R. the able-bodied or working-age population is officially defined as males 16–59 years of age and females 18–54 years of age. In 1985, this group supplied 90 percent of the labor force. Pension-age people (men 60 and older and women 55 and older) provided the remainder. Rapawy estimates that between 1980 and 2000 the labor force will grow somewhat faster than the working-age population, because of the participation in the labor force of more women of working age and of more pensioners.

His estimates indicate that in 1985 the total labor force consisted of about 153.3 million people, including 4.3 million in the armed forces, 114.5 million in nonagricultural activities, and 34.5 million in agriculture. Within total civilian nonagricultural employment, industry's share was a little more than a third; and construction, transport, trade, and education each had shares of about a tenth.

One may reasonably assume that the size of the armed forces is determined separately on national security grounds. It is also plausible that Soviet leaders consider it politically difficult, if not impossible, to increase the length of the work week or to raise pension-eligibility ages. Finally, as Rapawy explains, recent educational reform measures are not likely to bring a significant percentage of young people into the labor force at an earlier age.

Thus, labor force planners seeking to boost growth rates of output must try (1) to increase the participation of pension-age people in the labor force and (2) to steer what planners consider an inadequate number of available workers into what are deemed the high-priority branches and sub-branches of the economy.

TRENDS IN SOVIET GROSS NATIONAL PRODUCT

By Laurie Kurtzweg*

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SUMMARY

The Soviet economy has made solid gains since 1960—with gross national product (GNP) more than doubling, excluding the effects of price changes—but its growth has slowed, especially in the last decade. Annual rates of increase in GNP averaged over 4 percent between 1960 and 1975 but fell to about 2 percent between 1975 and 1986. As Soviet economic growth slowed, moreover, the USSR lost ground in its efforts to overtake the United States in the production of goods and services. Soviet GNP rose from about 50 percent of the US level in 1960 to more than 55 percent in 1975, but the share has slipped a little since then. The USSR's progress toward achieving Western standards of living also has stalled in the last decade, although its buildup of military power has continued.

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ALLOCATION OF GAINS FROM GROWTH

The retardation in the growth of Soviet GNP has resulted in slower growth of allocations to all of its major uses: investment, defense, and consumption. Still, in keeping with longstanding Soviet priorities, investment—a key source of future output—grew faster than consumption in most years, and its share of GNP increased. Defense's share of GNP also rose, taking into account changes in prices—partly because quantities of weapons grew rapidly during the 1960s, and partly because the prices of defense-related goods and services experienced more inflation than those of non-defense goods and services after 1970.

Although the USSR's total GNP is much smaller than that of the United States, levels of defense spending in the two countries are on a rough par. Soviet investment is approximately 85 percent of the US level, while Soviet consumption is less than 40 percent of that in the United States (or about a third of US consumption per capita).

REASONS FOR SLOWDOWN OF GROWTH

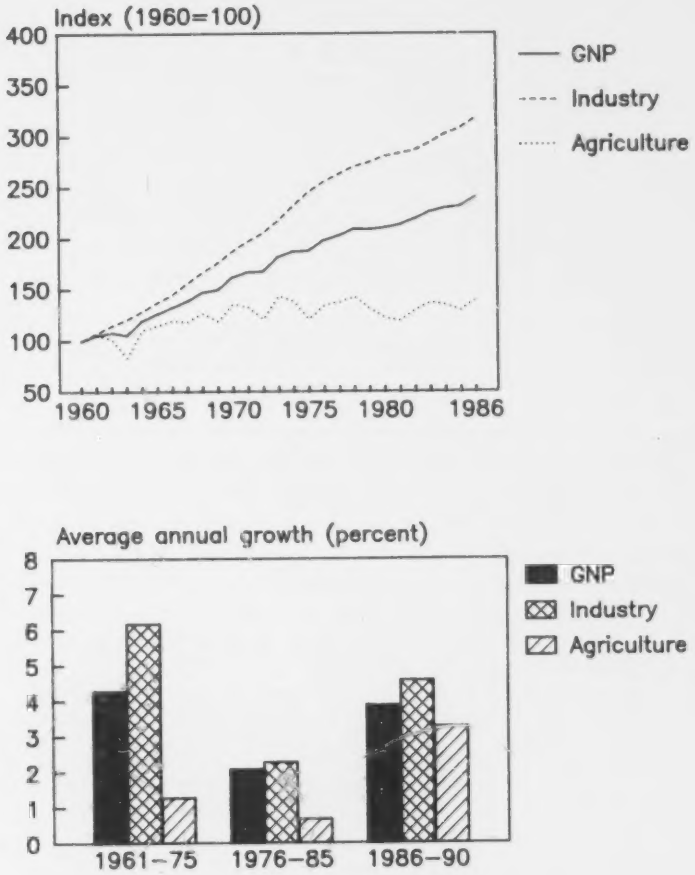
The slowdown in growth of Soviet GNP after the mid-1970s resulted partly from declining growth of the labor and capital used in the economy and partly from adverse trends in the productivity of these factors of production. Additions to the Soviet labor force declined steadily, and planners sharply cut the rates of increase in investment after 1975. The changed investment policy was part of an all-out effort to make economic growth depend less on increases in inputs and more on gains in productivity. Nonetheless, productivity of labor and capital combined has fallen in most years since the early 1970s.

Gradually diminishing returns on inputs to agriculture, oil production, and other extractive activities played a role in the worsening of productivity performance in the USSR, but inadequate technological progress became increasingly important in the last decade. Over the years, resources were allocated in large and rising amounts to extraction of raw materials, where the potential for improvements in productivity was limited by the quality of land and the accessibility of deposits. Some benefits accured—notably, hard currency earnings from oil exports. Despite the level and duration of the resource commitments, however, shortfalls from plan indicate that returns fell far short of Soviet expectations, especially in agriculture.

After the mid-1970s, advances in technology were not rapid enough to offset the effect of diminishing returns in extraction. Slow innovation in machine building—largely attributable to the weakness of incentives to introduce new products and production processes—was a major problem and one on which General Secretary Gorbachev is now focusing. Another, less visible problem was the inadequate flow of services. Long neglected in planners' allocations of resources, services grew only slightly faster than GNP in the USSR, instead of leading growth in the rest of the economy as in the West. Decreasing gains from international borrowing of new technology, especially from the United States, probably also contributed to productivity problems in the Soviet economy.

Figure 1

USSR: Trends in GNP and Industrial and Agricultural Output, 1960–86*



* Based on estimates of value added at 1982 factor cost

PLANS FOR GROWTH

Gorbachev has proclaimed his determination to reverse the slowdown of economic growth in the USSR. Soviet plans for 1986–90 imply that GNP is to increase by an average rate of roughly 4 percent per year and industry by slightly more than 4½ percent annually. Gorbachev's strategy to date has focused primarily on short-term improvements in "human factors" such as labor discipline and management. By the end of the 1986–90 period, however, he is

counting largely on rapid increases in the quantity and quality of machinery to modernize production technology. Technological advances are then to provide a long-term basis for growth—a far more challenging goal than short-term economic improvements.

Gorbachev has some grounds for satisfaction with the progress of his program to date. Results in 1986 were encouraging, with GNP growing at about the target rate and industry at a slower but still healthy pace of just over 3 percent. Agriculture's recovery from a poor harvest gave GNP a boost that is unlikely to be sustained, however, because the good showing in 1986 would have to be followed by a series of even better outcomes. Moreover, rates of growth of output planned for the remainder of the 1986–90 period would require faster increases in labor productivity than have been achieved since the late 1960s to early 1970s.

*Western scholars have found many reasons to think that the measurement of Russian national income is too important a task to leave to Russian statisticians.**

Introduction

Although the Soviet economy has made considerable progress over the past 25 years, its slackening growth—especially in the last decade—has drawn repeated expressions of concern from General Secretary Gorbachev. Economic growth slowed gradually during the 1960s and early 1970s, but the decleration sharpened in the mid-1970s. The negative trends are reflected both in official Soviet statistics and in the Central Intelligence Agency's independent estimates—used in this paper—of the USSR's gross national product (GNP).

To examine Soviet economic performance since 1960, this paper reviews trends in total GNP and its key components. It begins with a brief description of the nature of and rationale for these independent estimates of GNP. A summary of overall results follows, including a comparison of economic growth in the USSR and selected Western countries. Then the contributions of the major sectors of origin—particularly industry and agriculture—to trends in total GNP are discussed. The reasons for the widespread slowdown in economic growth since the mid-1970s are given special attention. Next follows a description of allocations of GNP to its major end uses: investment, defense, and consumption. Finally, Soviet economic plans for 1986–90 are summarized.

BACKGROUND ON ESTIMATES OF SOVIET GNP

In the passage quoted at the beginning of this paper, Abram Bergson summed up the longstanding skepticism about official Soviet statistics that has led Western researchers to reestimate economic growth for the USSR. The GNP estimates presented here seek to remedy several important shortcomings of official summary figures:

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*Abram Bergson, *The Real National Income of Soviet Russia since 1928* (Cambridge, Mass., Harvard University Press, 1961), p. 3.

—Inclusion of a substantial degree of disguised inflation (that is, price increases affecting the economy but omitted from official price indexes) in measures that should represent growth excluding the effects of price changes.
—Valuation in established (official) prices, which do not reflect the distribution of economic resources accurately.
—Exclusion of depreciation and most services—aside from some, such as freight transportation, that contribute directly to output of material goods.
—Inadequate information about methods of estimation.

The estimates of Soviet GNP used in this paper reflect the results of a recent revision, which moves the ruble price base for the estimates forward from 1970 to 1982. Except for the new prices used, the methods of estimation are mostly unchanged from those described in the CIA's benchmark (1982) study of GNP in 1970 prices.[1]

These GNP estimates are presented in alternative kinds of prices in order to track several aspects of Soviet economic performance:

—Real economic growth—excluding the effects of price changes—is analyzed using estimates of GNP and its major components valued in constant prices. That is, quantities of output is a series of years are valued at prices of a single base year (1982).
—Priorities in allocating resources are reflected by estimates of the major components of GNP in current prices, which are available for the new and old base years (1982, 1970, and, earlier, 1960). Current price measures are appropriate to assess priorities because decisions about spending are generally made on the basis of prices in effect at the time.[2]
—Levels of Soviet output are compared with those of the United States using estimates of each country's GNP valued first in domestic prices and then in prices of the other country.

Besides total GNP, estimates are available for major components broken down by end use and by sector of origin. The end use breakdown shows the distribution of output to final purchasers for uses such as consumption, investment, and defense.[3] In the breakdown by sector of origin, income resulting from the production of final output is allocated among the sectors producing that output—for example, industry, agriculture, and services.[4]

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[1] Joint Economic Committee, Congress of the United States, *USSR: Measures of Economic Growth and Development, 1950–80* (Washington, U.S. Government Printing Office, 1982). Appendix A of this paper summarizes the methods of estimating Soviet GNP in 1982 prices and notes any changes from previous methods.

[2] Price changes implied by GNP estimates in prices of 1970 and 1982 can be calculated for the periods between the new and old base years. Throughout this paper, price indexes implied by GNP estimates are weighted by quantities of the new base year (1982). That is, each price index is calculated by dividing a current value of output in the new base year by the same quantity of output valued in prices of the old base year (1970).

[3] Many products are sold from one enterprise to another—perhaps several times—before reaching consumers and other final purchasers. In order to count each product only once, GNP includes only final sales.

[4] Like the goods and services included in GNP, inputs to it must be counted only once. This rule admits primary inputs—labor, capital, and land—but excludes inputs of processed materials. The value of a sector's primary inputs is called "value added" to indicate that it originates only from inputs in addition to those purchased from other sectors.

In an effort to approximate better the value of resources used in production and allocated to end uses, the CIA adjusts its estimates of Soviet GNP from established prices to factor cost. The adjustment corrects for several shortcomings of Soviet established prices: [5]

—Large excise taxes, levied at highly differentiated rates, mostly on consumer goods.
—Subsidies, mostly on food and services such as housing.
—Wide variations in profits, which do not reflect differences in the contribution of capital to production.

The measures of Soviet GNP presented in this paper cover all state-administered economic activities and part of the "second economy" of private and illegal or questionably legal activities.[6] Base-year GNP includes estimated values for the entire legal private economy in agriculture and housing and for all privately provided services. No distinction is made as to which private services the Soviets classify as legal or illegal. For estimates of growth of GNP, the data used to track changes in agriculture and housing include legal private activities along with state-administered ones. Because so little information is available on privately provided services, however, most of the data used to estimate services growth include only state activities.

COMPARISON OF GNP ESTIMATES WITH OFFICIAL SOVIET STATISTICS

A comparison of growth of GNP and net material product (NMP)—the official Soviet measure closest to GNP—shows similar patterns over time, including the slowdown since the mid-1970's (figure 2).[7] Rates of NMP growth are higher, however, primarily because inadequate adjustments for price changes result in a substantial degree of disguised inflation:

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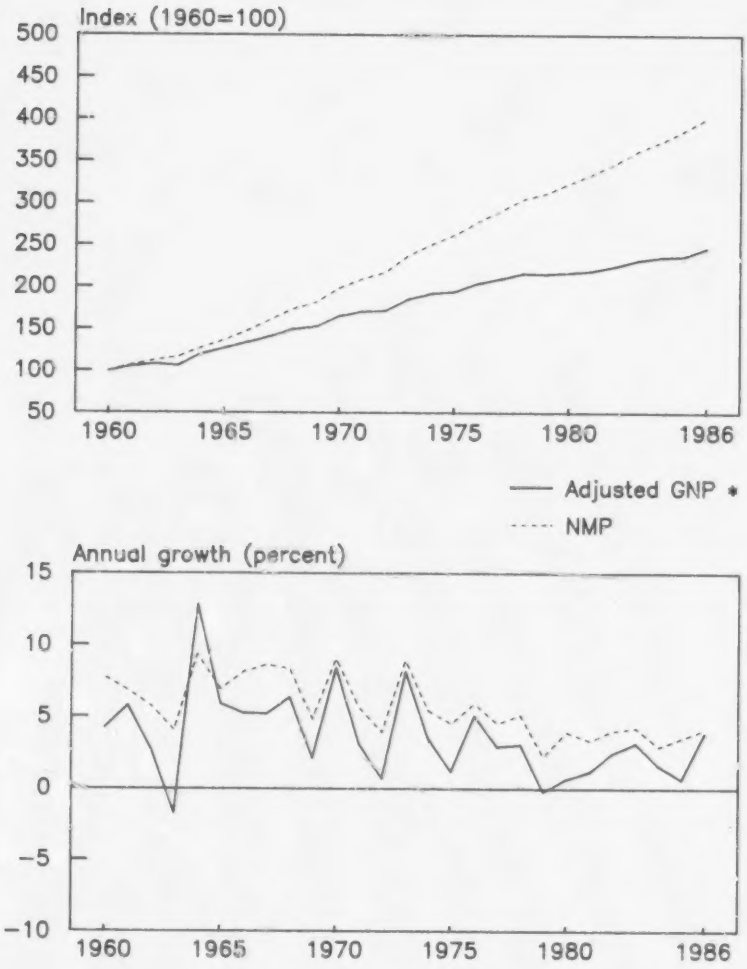
[5] The factor cost adjustment is made by first subtracting excise taxes, subsidies, and profits from base-year (1982) values of the components of GNP in established prices. Returns to fixed and working capital—calculated at a uniform rate of 12 percent—are then added back to GNP. In principle, returns to agricultural land and other natural resources also should be estimated and added to GNP, but this is not done at present. Growth of total GNP—at factor cost as well as in established prices—is estimated as a weighted average of growth of the components, with component values in the base year serving as weights.

[6] A standard definition, description, and general analysis of the Soviet second economy are given by Gregory Grossman in "The 'Second Economy' in the USSR," *Problems of Communism* (Sept.-Oct. 1977, pp. 25–40). The contribution of the second economy to GNP is discussed in Gertrude E. Schroeder and Rush V. Greenslade, "On the Measurement of the Second Economy in the USSR," *ACES Bulletin* (Spring 1979, pp. 3–21). Also see Appendix A of this paper for a further discussion of problems of including the second economy in GNP estimates.

[7] The term "net material product" is used by Western economists to flag the exclusion of depreciation (the "gross" component of GNP) and of services that do not contribute directly to material output. The Soviets call their meaure "national income produced."

Figure 2
USSR: Trends in GNP and NMP, 1960–1986



* Coverage adjusted to match that of NMP by removing services that do not contribute directly to material output.

[In Percent]

	Average annual growth			Difference between adjusted GNP growth and NMP growth [2]
	GNP	Adjusted GNP [1]	NMP	
1961–65	4.8	5.0	6.5	1.5
1966–70	5.1	5.4	7.8	2.4
1971–75	3.0	3.3	5.7	2.4

[In Percent]

	Average annual growth			Difference between adjusted GNP growth and NMP growth [2]
	GNP	Adjusted GNP [1]	NMP	
1976–80	2.3	2.3	4.3	2.0
1981–85	1.9	1.8	3.6	1.8

[1] To minimize the effects of different coverage on this comparison, estimates of GNP have been adjusted to exclude services that do not contribute directly to material output. Also, the weights used to calculate growth of adjusted GNP are estimates of 1982 value added in established prices, rather than at factor cost.

[2] After 1961–65, differences between adjusted GNP growth and NMP growth decrease with time. This result is consistent with the "index number effect" according to which rates of economic growth tend to be higher, the earlier the price base used in estimating them. NMP is measured using a series of linked price bases (1958, 1965, and 1973), all earlier than that for GNP. The exception in 1961–65 may be due to weaker connections between Soviet prices and costs in 1958 than in the later base years used for NMP.

Although the Soviets claim that NMP statistics are based on constant prices, new products often enter at prices that include inflated allowances for improvements in quality. In contrast, the CIA's GNP estimates avoid the disguised inflation problem whenever possible by using quantity data (mostly from Soviet sources) on output of individual products valued at prices of a fixed base year.[8]

Official Soviet statistics therefore imply lower rates of inflation than GNP estimates do. Like higher growth rates for NMP, this result follows from the problem of inflation in new product prices. Calculations comparing GNP estimates in 1960, 1970, and 1982 prices indicate that inflation averaged a little over 2 percent per year between 1970 and 1982, a rate similar to that between 1960 and 1970. In contrast, official NMP statistics imply that inflation averaged less than half a percent per year between 1970 and 1982 and was negligible between 1960 and 1970.

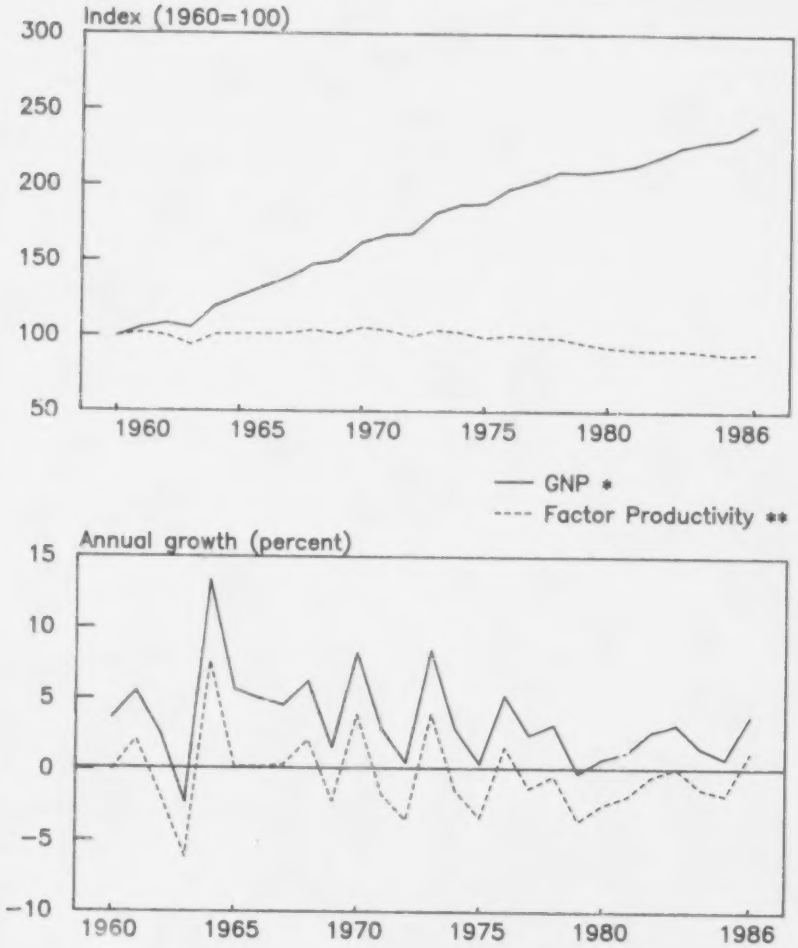
Trends in Total GNP and Productivity

The Soviet economy has made solid gains in the past 25 years, but its growth has slowed, especially in the last decade. GNP more than doubled between 1960 and 1986, with growth averaging 3.4 percent per year (figure 3). Its total value at the end of the period was about 710 billion rubles at 1982 factor cost. Annual rates of increase fell, however, from an average of 4.3 percent before 1975 to 2.2 percent thereafter (table 1).

[8] The use of these quantity data, however, entails problems of another kind: incorporating changes in the quality and mix of output in the estimates. These problems are discussed briefly in Appendix A.

Figure 3

USSR: Trends in GNP and Factor Productivity, 1960–86



* Based on estimates of value added at 1982 factor cost

** Input indexes are based on hours worked by labor, capital stock in 1973 prices (official Soviet data), and value of land in 1982 prices. Inputs are combined using weights derived from shares of labor, capital, and land in 1982 value added at factor cost.

TABLE 1.—USSR: GROWTH OF GNP, FACTOR INPUTS, AND FACTOR PRODUCTIVITY, 1961–86 [1]

[In percent]

	GNP	Factor productivity	Factor inputs			
			Combined	Labor	Capital	Land
Average annual growth:						
1961–65	4.8	0.3	4.5	1.5	8.8	0.2
1966–70	5.1	.8	4.2	2.0	7.4	0

TABLE 1.—USSR: GROWTH OF GNP, FACTOR INPUTS, AND FACTOR PRODUCTIVITY, 1961–86 [1]—Continued

[In percent]

	GNP	Factor productivity	Factor inputs			
			Combined	Labor	Capital	Land
1971–75	3.0	−1.3	4.3	1.7	8.0	0.1
1976–80	2.3	−1.2	3.6	1.2	6.9	−.1
1981–85	1.9	−1.0	3.0	.7	6.2	−.2
Annual growth:						
1981	1.3	−1.8	3.2	.9	6.4	−.1
1982	2.7	−.4	3.2	1.0	6.3	−.1
1983	3.2	.1	3.0	.7	6.3	.1
1984	1.5	−1.3	2.9	.5	6.3	−.1
1985	.8	−1.8	2.6	.4	5.8	−.7
1986 preliminary	3.8	1.2	2.5	.4	5.5	−.1

[1] GNP growth is based on estimates of value added at 1982 factor cost. The growth of inputs is based on estimates of hours worked by labor, value of capital stock in 1973 prices (official Soviet data on value, including livestock, at beginning of output year), and value of land in 1982 prices (land broken down by type—unimproved, irrigated, or drained—and by crop). Inputs are combined using weights derived from shares of labor (wages, social insurance, and other income), capital (depreciation and an imputed return), and land (rent) in 1982 value added at factor cost.

Up through the early 1970s, the slippage in economic growth was gradual, resulting largely from diminishing returns on inputs to agriculture and other activities based on extraction of the USSR's abundant natural resources. Nonetheless, the Soviets had few grounds for concern, as GNP climbed at a healthy average pace of 5.1 percent per year during the late 1960s. The supply of inputs to the economy expanded at fairly steady rates, and annual gains in productivity of labor and capital combined (factor productivity) averaged 0.8 percent.

By the early 1970s, however, with additions to the working age population declining and participation in the labor force already high, increases in labor inputs began to dwindle steadily. In response to these trends, planners launched an all-out effort to shift the economy from extensive growth—that is, growth based on increases in inputs—to intensive growth—that is, growth based on improvements in productivity. Departing sharply from past practice, they allowed the rates of increase in investment, and consequently in capital stock, to slow markedly in the mid-1970s. At the same time, planned rates of output growth were reduced in an attempt to let plant managers concentrate on improving the efficiency of input use.

Instead of accelerating, however, GNP growth fell to an average of 2.3 percent per year during the late 1970s. Factor productivity declined and continued to do so through 1985, except for a slight rise in 1983. The adverse economic trends since the mid-1970s are the primary focus of Gorbachev's urgent calls for a turnaround in growth. Although average results for 1983–85—and especially 1986 results—are better than those of the final Brezhnev years, a major economic revival remains a goal rather than an accomplishment.

The slowdown in the growth of Soviet GNP frustrated Moscow's efforts to overtake the United States in the production of goods and services. Levels of Soviet GNP have long been well below those of the United States. Until the mid-1970s, however, GNP was increasing faster in the USSR than in the United States. As a result,

Soviet GNP rose from about 50 percent of the US level in 1960 to more than 55 percent in 1975.[9] During the same period, Soviet GNP growth was similar to average growth in European countries belonging to the Organization for Economic Cooperation and Development (OECD) (table 2).[10]

TABLE 2.—COMPARISON OF GNP GROWTH IN USSR AND WESTERN COUNTRIES, 1961–85

[In percent]

	USSR	US [1]	European OECD (GDP) [2]				
			Total	FRG	France	Italy	UK
Average annual growth:							
1961–65	4.8	4.6	4.9	4.8	5.8	5.2	3.2
1966–70	5.1	3.0	4.6	4.2	5.4	6.2	2.5
1971–75	3.0	2.2	3.0	2.1	4.0	2.4	2.2
1976–80	2.3	3.4	2.9	3.3	3.3	3.8	1.6
1981–85	1.9	2.4	1.4	1.3	1.1	.9	1.9
Annual growth:							
1981	1.3	1.9	0	.2	.5	.2	−1.2
1982	2.7	−2.5	.6	−.6	1.8	−.5	1.0
1983	3.2	3.6	1.6	1.5	.7	−.2	3.8
1984	1.5	6.4	2.4	2.7	1.5	2.8	2.2
1985	.8	2.7	2.5	2.6	1.1	2.3	3.7

[1] Calculated from GNP in 1982 prices, published in "Survey of Current Business," September 1986.
[2] Calculated from GDP in 1980 prices, published in OECD, "National Accounts, 1960–1985" (Main Aggregates, Vol I). Total GDP in the European OECD is calculated using official exchange rates to convert data for individual countries to US dollars.

Growth in the United States and the European OECD countries slowed markedly after 1973, but the slowdown in Soviet growth was also sharp. Average annual rates of increase in GNP were smaller for the USSR than for the United States in the late 1970s and early 1980s, so that Soviet GNP slipped to about 55 percent of the US level in 1985. Compared with growth in the European OECD countries, Soviet rates of gain also were a bit slower in the late 1970s but slightly faster in the early 1980s.

Like growth of GNP, productivity growth in both the USSR and the West dropped off abruptly in the early to mid-1970s. Comparing Soviet and Western GNP is not an easy task, and data limitations make comparing Soviet and Western productivity more difficult

[9] These shares represent the geometric mean of a comparison using US market prices (dollars) as weights and another comparison using Soviet established price weights (rubles). The base year for both the dollar and the ruble price weights is 1982. The results of dollar and ruble comparisons are quite different because relative prices differ markedly between the United States and the USSR, as does the structure of output. Each country's GNP appears smaller when weighted by its own prices because each produces relatively large quantities of goods that are relatively cheap in terms of its own resources. Comparisons in both sets of prices are valid, but the geometric mean provides a convenient single estimate of proportion.

[10] For all countries shown, estimates of real growth are weighted by values of output in domestic currencies. Base years for these weights are 1982 for the United States and the USSR and 1980 for the European OECD countries.

For the European OECD countries, growth rates apply to gross domestic product (GDP) rather than gross national product. Differences between the two measures reflect differences—usually small—in coverage of payments for labor and capital services. A country's GNP includes payments to its nationals for performing such services, even outside its borders, while GDP includes payments for services performed within the country's borders, even by foreigners.

Strictly speaking, the present "GNP" measures for the USSR also reflect GDP because payments for labor and capital services exchanged with other countries have not been estimated. Given the Soviet Government's tight controls on incomes of this kind, however, differences between GNP and GDP are undoubtedly small.

still.[11] Nevertheless, the comparisons that can be made are so strikingly different that it is clear that the growth of Soviet factor productivity has been unimpressive relative to that of Western countries at similar levels of economic development (such as Italy). Moreover, productivity has accounted for a much smaller share of output growth in the USSR than in the West.

Abram Bergson's analysis of the adverse changes in Soviet productivity growth points to diminishing returns from borrowing Western technology and to slowing replacement of obsolescent capital—due to slowing investment growth—as major influences.[12] John Kendrick has judged like influences as important in explaining the slowdown of productivity growth in the West.[13] Growth of outlays on research and development—a major source of technological knowledge—declined in Western countries, especially the United States, and opportunities for international transfers of technology were reduced. In addition, rates at which innovations spread through Western economies slowed as the average age of capital rose.

A recent study by William Baumol suggests that the USSR's unimpressive productivity record may result from characteristics of its system or policies—or both—that it shares with other centraliy planned economies.[14] Taking a century-long view of labor productivity (he analyzes this measure rather than factor productivity), Baumol argues that, for an industrialized economy, the lower its starting level of labor productivity, the higher its long-run productivity growth is likely to be. As a result, international differences in productivity growth lead to convergence toward the productivity levels of the leaders. Baumol attributes this productivity convergence largely to spillovers of innovation—and, to a lesser extent, of investment—from the leading countries to others. Since 1950, however, he finds that labor productivity in centrally planned economies has converged more slowly, and to a generally lower level, than in free-market economies.

Trends by Major Sector of Origin

Like the growth of total GNP, growth in all major sectors of the Soviet economy has slowed over the last 25 years (table 3). After 15 years of expansion at gradually declining rates, industry experienced a sharp fall in growth after 1975. This drop, combined with a reduced rate of increase in transport services, played a key role in the slide of GNP growth in the past decade. When growth slowed

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[11] Many studies of productivity are based on less inclusive output measures than GNP. Services often are excluded because estimates of their output depend on assumptions about productivity, and depreciation is sometimes excluded as well. See for exaple Edward F. Denison, "Accounting for Slower Economic Growth: An Update," in John W. Kendrick, ed., *International Comparisons of Productivity and Causes of the Slowdown* (Cambridge, Mass., American Enterprise Institute/Ballinger, 1984).

[12] See his chapter, "Technological Progress," in Abram Bergson and Herbert S. Levine, eds., *The Soviet Economy: Toward the Year 2000* (London, George Allen & Unwin, 1983) and chapters 6, 7, and 9 of Bergson's *Productivity and the Social System—The USSR and the West* (Cambridge, Mass., Harvard University Press, 1978).

[13] See his chapter, "International Comparisons of Recent Productivity Trends," in William Fellner, ed., *Contemporary Economic Problems: Demand, Productivity, and Population* (Washington, American Enterprise Institute for Public Policy Research, 1981).

[14] William J. Baumol, "Productivity Growth, Convergence, and Welfare: What the Long-Run Data Show," *American Economic Review*, (Dec. 1986, pp. 1072–1085).

in Soviet industry, moreover, no other major sector of the economy moved forward to pick up the slack. Growth in agriculture lagged behind that in the rest of the economy, especially during the 1970s. Also, the service sector did not boost GNP growth in the USSR nearly as much as it did in Western countries—although rates of increase in services fell less markedly than in the other major sectors.

TABLE 3.—USSR: GNP GROWTH BY SECTOR OF ORIGIN, 1961–86 [1]

[Average annual rates in percent]

Sector of origin	1961–65	1966–70	1971–75	1976–80	1981–85	1986 preliminary
Industry	6.5	6.4	5.5	2.7	1.9	3.1
Construction	4.7	5.4	4.5	2.9	2.9	3.4
Agriculture	2.8	3.4	−2.3	.2	1.2	8.5
Transportation	10.2	7.2	6.6	3.6	2.3	3.9
Communications	7.3	8.6	6.4	4.7	3.8	5.6
Trade	5.0	7.3	4.5	2.7	1.6	−.2
Services [2]	4.4	4.3	3.5	2.7	2.2	2.0
Military personnel [3]	2.0	3.7	2.0	1.5	.3	0
Total GNP	4.8	5.1	3.0	2.3	1.9	3.8

[1] Based on estimates of value added at 1982 factor cost.
[2] Including consumer services (housing, utilities, repair and personnel care, recreation, education, health), science (research and development) credit and insurance, and government administration (general agricultural programs, forestry, state administration, culture, municipal services, civilian police).
[3] Including military wages, with conscript costs calculated using the minimum industrial wage.

In industry, which has grown faster than GNP for most of the post-1960 period, the growth slowdown paralleled that in the economy as a whole. The gradual slippage of industrial growth before the mid-1970s resulted largely from diminishing returns in the extractive branches. To cope with continually rising costs, planners allocated resources in large and increasing amounts to oil and other raw materials, but returns to these resources diminished as the most accessible deposits were used up. After the mid-1970s, however, growth in branches with greater opportunities for technological advances—especially machinery—not only failed to offset declining growth in extractive industries but even dropped. Under these circumstances, the urgency of Gorbachev's call for increases in the quantity and quality of machinery output is easy to understand.

Despite receiving a substantial share of investment—nearly a fifth—agriculture has been a drag on long-term increases in GNP and the major source of short-term fluctuations in GNP. In Western countries, GNP growth has benefited from the transfer of resources out of agriculture into sectors with better growth potential, but such shifts have been relatively slow in the USSR.[15]

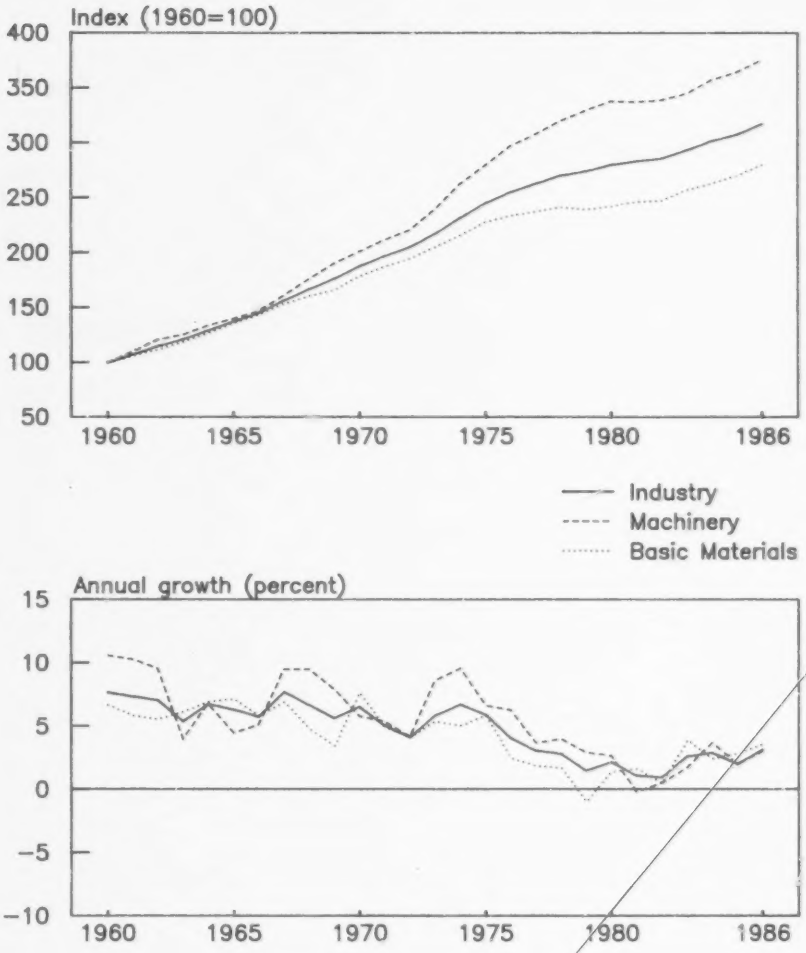
INDUSTRY

Soviet industry tripled its output between 1960 and 1986 (figure 4). Average annual rates of increase fell from 6.2 percent between 1960 and 1975 to 2.4 percent after 1975, but have improved somewhat since 1982. Part of the slowdown of industrial growth was ex-

[15] See Bergson, "Technological Progress," pp. 44–47.

Figure 4

USSR: Trends in Industrial Production, 1960–1986 *



* Based on estimates of value added at 1982 factor cost

plained by declining growth of labor and capital inputs, but adverse changes in productivity also played a part (table 4). In particular, when industrial growth slumped in the mid-1970s, the rising trend in factor productivity was reversed. The rate of productivity decline eased in 1983–85, however, and preliminary results indicate that productivity nearly stabilized in 1986.

TABLE 4.—USSR: GROWTH OF INDUSTRIAL OUTPUT, FACTOR INPUTS, AND FACTOR PRODUCTIVITY, 1961–86 [1]

[In percent]

	Industrial output	Factor productivity	Factor inputs		
			Combined	Labor	Capital
Average annual growth:					
1961–65	6.5	- 1.0	7.6	2.9	11.4
1966–70	6.4	.2	6.2	3.1	8.8
1971–75	5.5	0	5.5	1.5	8.7
1976–80	2.7	−2.1	4.9	1.4	7.7
1981–85	1.9	−2.1	4.1	.6	7.0
Annual growth:					
1981	1.1	−3.3	4.6	.7	7.8
1982	.9	−3.2	4.2	.8	7.0
1983	2.6	−1.4	4.0	.4	6.9
1984	2.9	−1.0	4.0	.5	6.8
1985	2.0	−1.8	3.9	.4	6.6
1986 preliminary	3.1	−.4	3.5	.4	6.1

[1] Growth of industrial output is based on estimates of value added at 1982 factor cost. Input growth is based on estimates of hours worked by labor and value of capital stock in 1973 prices (official Soviet data for beginning of output year). Inputs are combined using weights derived from shares of labor (wages, social insurance, and other income) and capital (depreciation and an imputed return) in 1982 value added at factor cost.

Slowdown of growth, 1976–82

The slowdown of Soviet industrial growth in the last decade was too pronounced to be explained solely by long-term tendencies like diminishing returns in the extraction of natural resources. Other important influences were:[16]

—Bottlenecks resulting from problems in production and transportation of basic materials like steel and cement.

—Aggravation of these bottlenecks by severe winters in 1979 and 1982.

—Difficulties in introducing new machinery products and technologies.

—A sharp cutback in growth of investment allocated to industry, including civilian machine building.

Reduced growth of basic materials set the pattern for the deceleration of industrial growth in 1976–78 and the further deterioration in 1979–82 (table 5). Because these materials (ferrous and nonferrous metals, chemicals, wood products, and construction materials) are used throughout industry, irregularities in their supply interfere with production downstream. Their growth faltered in 1976 and worsened markedly in 1979, when production of ferrous metals, chemicals, wood products, and construction materials declined in absolute terms. Longstanding neglect of investment in developing sources of raw materials for these branches was part of the problem. Severe winters and weather-related problems in transportation—especially by rail—also disrupted production in 1979 and 1982.

[16] The discussion in this section owes much to Gertrude E. Schroeder's analysis, reported in "The Slowdown in Soviet Industry, 1976–82," *Soviet Economy*, (vol. 1, no. 1, Jan.–Mar. 1986, pp. 42–74).

TABLE 5.—USSR: INDUSTRIAL GROWTH BY SECTOR, 1971–86 [1]

[Average annual rates in percent]

	1971–75	1976–78	1979–82	1983–85	1986 preliminary
Basic materials	5.0	2.0	0.6	3.0	3.5
Ferrous metals	4.2	2.0	−.6	2.2	2.8
Nonferrous metals	5.7	1.4	1.1	3.0	3.0
Chemicals	8.3	4.1	2.2	4.5	3.8
Wood, pulp, and paper	2.5	−.3	.1	2.6	4.5
Construction materials	5.1	2.3	.2	2.3	3.2
Energy	6.0	4.4	2.5	2.3	3.8
Fuel	5.4	4.0	2.0	.9	3.9
Electric power	7.0	5.0	3.2	4.1	3.6
Machinery	6.8	4.6	1.4	2.4	3.0
Consumer nondurables	3.4	1.9	1.7	1.7	1.7
Light industry	2.6	2.9	1.2	2.2	1.5
Food industry	4.1	1.1	2.2	1.3	2.0
Total industry	5.5	3.3	1.4	2.5	3.1

[1] Based on estimates of value added at 1982 factor cost.

While bottlenecks in supplies of basic materials were developing, rates of increase of machinery output tapered off quite steadily through 1981–82. The timing of the slowdown was similar for civilian and military machinery, although growth was somewhat higher for the civilian component. Gorbachev's recent criticisms of machine building suggest that chronic problems with the introduction and mastering of new products and new manufacturing technologies became more severe during the 1970s. Moreover, CIA estimates indicate that output of military machinery failed to increase in the early 1980s. As a result, growth of total machinery was slightly lower than growth of total industry in 1981–85—the first time since 1960 that this had occurred for more than a few years.

A sharp cutback in the rate of growth of investment in industry also played a major part in the slowdown of industrial growth. In the mid-1970s, when Soviet planners launched their all-out effort to shift the economy from extensive to intensive growth, they did not spare industry from reductions in planned investment growth. Industrial investment in 1976–80, for example, increased at an average rate of 3.4 percent annually, down from 6.7 percent in 1971–75 (table 6). Growth of investment in machinery fell abruptly as well, although it remained a bit faster than growth of total industrial investment. Investment in civilian machine-building ministries was particularly hard hit. After a few years, rates of increase of capital stock also faltered, as reduced investment growth affected additions to capacity. Meanwhile, old capital was left in service longer—a tactic that helped to keep up the growth of capital stock at the cost of diverting efforts from new production to repair of aging plant and equipment.

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TABLE 6.—USSR: GROWTH OF INVESTMENT BY SECTOR, 1961–85 [1]

[Average annual rates in percent]

	1961–65	1966–70	1971–75	1976–80	1981–85
Industry	6.8	6.7	6.7	3.4	4.2
Basic materials	5.6	5.3	6.1	.6	.8
Energy	8.5	4.4	6.1	7.0	8.0
Machinery	8.7	13.7	9.4	4.0	4.0
Consumer nondurables	4.2	7.0	4.8	2.1	2.1
Construction	4.1	15.3	7.7	4.5	.4
Agriculture	11.7	8.6	10.3	2.7	1.1
Transportation and communications	6.7	7.2	9.7	4.8	3.9
Housing	.4	6.9	4.0	1.9	5.9
Other	7.6	7.8	4.0	3.4	3.2
Total investment	6.2	7.6	6.8	3.3	3.5

[1] Based on official Soviet data on value of investment in 1984 prices. GNP estimates of investment—which are available only for the total, not by receiving sector—are roughly similar to official data in timing of changes in growth rates. Rates of investment growth based on GNP estimates are usually lower than those based on official Soviet data, however, because independent estimates of growth of the construction component tend to be lower than official figures.

Upturn in growth, 1983–86

Soviet industrial growth in 1983–85 turned up from the depressed rate of 1979–82 but remained somewhat below the 1976–78 pace. In 1986 industry made further gains and grew at its fastest rate in a decade. A variety of small improvements have contributed to the post-1982 upturn. Output of basic materials rebounded in 1983, thanks in part to mild weather following the difficult winter of 1982. Introductions of new capacity, combined with renovations of existing plant, eased some of the constraints on production of these materials. In the rest of industry, too, a moderate upturn of investment growth in 1981–83 helped increase production capacity. Moreover, transportation of goods to industrial users recovered under a new Minister of Railways, appointed by Andropov, and growth of machinery output accelerated. As a result of this mini-recovery, industry's ability to cope with setbacks apparently has improved since 1982. Despite another severe winter that disrupted production in early 1985, growth for that year was not far off the pace of 1983–84.

Industrial prices

Comparisons of estimates of industry's contribution to GNP in prices of 1970 and 1982 imply that inflation in industry averaged a little more than 2 percent annually between those years. This inflation was largely due to the increasing difficulty of extracting raw materials—especially fuels and ferrous metals—which pushed up prices substantially faster in those branches. Difficulties in the extractive branches thus created inflationary pressures even as they contributed to the slowdown in growth of real output.

Inflation in machinery prices does not provide as much insight into the problems of machinery production as rising costs do for the extraction of raw materials. Deficiencies in the rules for pricing new products, however, have played a major role in the chronic problems of poor quality of machinery to which Gorbachev is calling attention. (See inset.) Soviet pricing rules do not distinguish adequately between major improvements, which often entail risks

for producers, and minor changes in specifications, for which risks are few. For the vast majority of products, prices are set administratively and, once set, are very difficult to raise. But if a product with a set price is modified, its producer can submit that the "new, improved" product warrants a higher price. Because major changes can require new methods of production and jeopardize fulfillment of output plans, producers typically prefer minor alterations. In a market economy, producers' preferences would be tempered by opportunities for purchasers to switch suppliers if a modified product is not worth its new, higher price. Such opportunities are rare in the USSR, however, and besides, purchasers who pay inflated prices for inputs often can pass the inflation along to their own customers.

Problems of Pricing new Products

*Soviet rules for pricing new products permit higher prices than for similar goods already in production only if improved specifications benefit the customers for these products. The price increase allowed for a new product is based on projections of the product's "economic effect." This effect is estimated from formulas including factors such as increases in productive capacity and reductions in user costs. According to a deputy chairman of the Soviet State Price Committee, however, problems arise in the application of these rules:**

> *"The practice of price formation shows that, instead of creating technology [that benefits both producers and users], enterprises not infrequently attempt to strengthen their own economic position at the expense of raising prices too high.*
>
> *"Checks show that some enterprises, after obtaining an incentive markup [in the price of a new product] with the user's agreement on the [product's economic] effect, stop worrying about the quality of output and produce equipment for which actual characteristics are significantly inferior to those stipulated in the normative-technical documentation.*
>
> *"In accordance with the regulations on deliveries of output for use in production, when the customer points out errors, the producer is obliged to eliminate the defects of equipment at his own expense and to pay a fine of an established amount. The customer can return rejected equipment for a refund of the entire sum paid (prices and markups). But users of machine-building output use the rights granted to them weakly in control over prices and the quality of new technology."*

AGRICULTURE

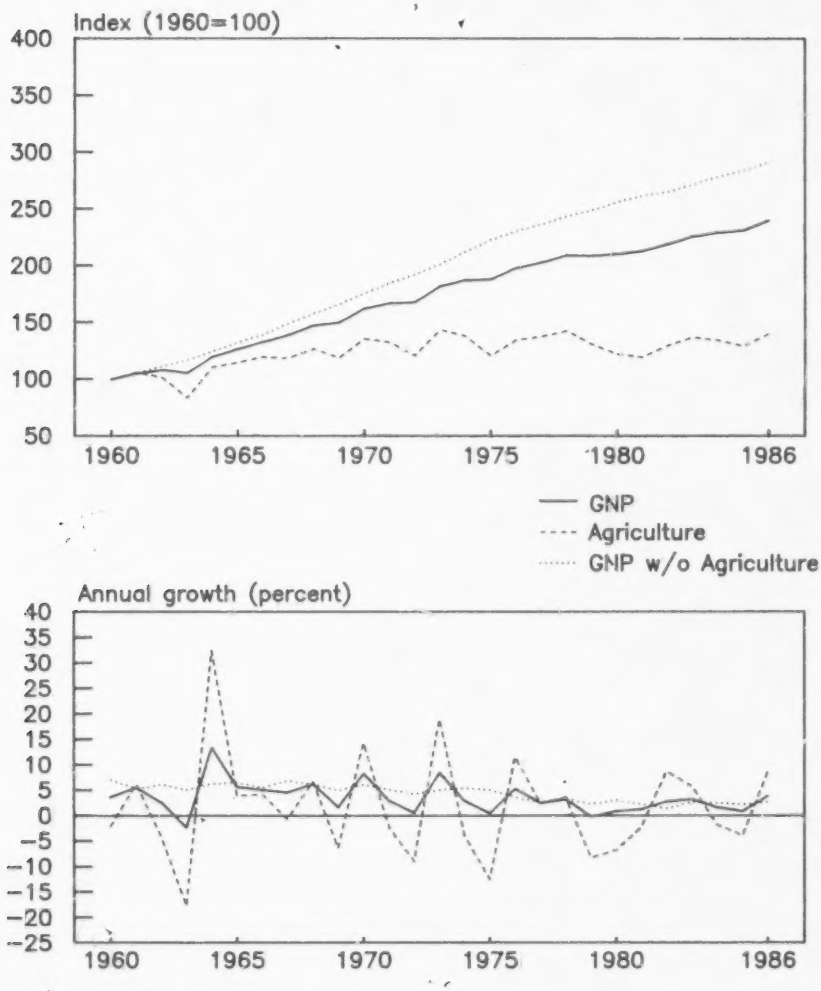
Agriculture's contribution to Soviet GNP increased by about 40 percent between 1960 and 1986, but most of the gains were achieved before 1970. Since then, advances in some years have been followed by setbacks in others. On balance, agriculture exert-

*L. Rozenova, "Prices and the Quality of Technology," *Ekonomicheskaya gazeta* (No. 7, 1987, p. 17).

ed a substantial drag on GNP growth in the 1970s and early 1980s (figure 5).[17]

Figure 5

USSR: Trends in Agriculture and GNP, 1960–1986 *



* Based on estimates of value added at 1982 factor cost

Because weather exerts a far stronger influence on agricultural production than on output of other sectors of the economy, growth rates of total GNP have often diverged widely from the more stable

[17]Agriculture's contribution to GNP is measured as value added by the primary inputs (labor, capital, and land) used in farm production. Another measure of agricultural activity is net output, which includes inputs purchased from other sectors (such as fertilizer) as well as value added. Both measures exclude output produced and used on farms (such as feed for livestock).

rates of GNP excluding agriculture. For example, while industrial growth improved in 1983 and sustained a faster pace in the following years, agriculture gained in 1983 (as well as in 1982) but then fell back before rebounding in 1986. As a result, GNP growth rose markedly in 1983, slipped to depressed rates in 1984–85, and increased strongly again in 1986.

Problems of the 1970s

Although the 1971–80 period included some years of extremely unfavorable weather, Soviet leaders themselves acknowledge that problems besides weather contributed substantially to low growth and poor returns on investment.[18]

—Productivity declined as downtime of agricultural machinery rose and growth in livestock herds outstripped growth in feed availability. Because wage payments have been largely guaranteed since the mid-1960s—regardless of output—farmers had little incentive to minimize the effects of poor weather and other problems.

—Delivery of industrial inputs to agriculture and processing of farm output became more difficult to synchronize as the size and interdependence of the economy increased. This led farms to devote a growing share of their own resources to activities such as repair of equipment and application of fertilizer that specialized organizations should have provided.

—Despite a large and—until the mid-1970s—rising share of investment in agriculture, allocations of investment were inappropriate. Construction of livestock facilities was overemphasized, while the shares of investment allocated to industries supporting agriculture and to rural housing were cut. As a result, industrial inputs such as farm machinery and pesticides have been deficient in quality and assortment, and primitive rural living conditions have encouraged younger, skilled workers to migrate to cities.

Moreover, Soviet authors have complained about immense losses of agricultural products between the farms and the food processing industries. The farm-to-market road network is grossly inadequate, the average length of haul for farm products increased, and procurement and transportation organizations lacked sufficient incentives to prevent damage and spoilage.[19]

There are parallels between these problems in agriculture and the slowdown of industrial growth. Bottlenecks in production and transportation of inputs were culprits in both cases. And although investment in agriculture increased faster than in industry, in both cases allocations often failed to reach producers who needed additions to capacity most to sustain output growth.

Recovery in the 1980s

Agricultural performance picked up after the introduction of the 1982 Food Program, largely because of a recovery in output of live-

[18] For a discussion of agricultural policy and performance, see the paper by Penelope Doolittle and Margaret Hughes, "Gorbachev's Agricultural Policy: Building on the Brezhnev Food Program," in this volume.

[19] See Judith Flynn and Barbara Severin, "Soviet Agricultural Transport: Bottlenecks to Continue," in this volume.

stock products (table 7). Increased feed availability, milder winter weather, large grain imports, and improved feeding practices all contributed to the improvement. Until 1986, crop production was a disappointment, however, partly because of drier, less favorable weather conditions. Average annual output of grain, sugarbeets, potatoes, and oilseeds during 1981–85 was below 1976–80 average levels.

TABLE 7.—USSR: GROWTH OF AGRICULTURAL OUTPUT AND PURCHASED INPUTS, 1961–86 [1]

[Average annual rates in percent]

	1961–70	1971–75	1976–80	1981–85	1986 preliminary
Net farm output [2]	3.6	−0.6	0.8	2.1	7.3
Crops	3.5	−1.5	.9	1.2	9.4
Livestock	3.8	.5	.7	2.9	5.2
Purchased inputs [3]	6.5	6.2	2.5	4.4	4.5
Value added in agriculture [4]	3.1	−2.3	.2	1.2	8.5

[1] Based on estimates of net output and purchased inputs in 1982 prices.
[2] Including inputs purchased from sectors outside agriculture but excluding output produced and used on farms (such as feed for livestock).
[3] Including agricultural chemicals, fuels and power, machinery repair, and various feed ingredients.
[4] Derived by subtracting purchased inputs from net farm output.

Increased purchases by agriculture from other sectors accounted for some of the post-1982 gains in farm output. The use of processed feeds rose markedly, and the rapid rise in the application of chemical fertilizers and pesticides probably kept crop production from turning out worse than it did.

Resource costs in agriculture

The share of Soviet economic resources devoted to agriculture is very large by Western standards, and resource commitments to the agricultural sector continue to rise. About a fifth of the labor force and the same share of capital stock (excluding housing and other services) are engaged in the sector. In the United States, comparable shares are less than a twentieth.

Calculations based on agriculture's contribution to GNP in 1970 and 1982 prices imply that prices in agriculture—reflecting the cost of these resources—increased at an average rate of about 3 percent per year between 1970 and 1982. This rate exceeded the inflation rate in all branches of industry except fuels and ferrous metals, where extraction costs were rising rapidly.

OTHER MAJOR SECTORS

After industry and agriculture, the next largest share of GNP by sector of origin is provided by services—including consumer services (such as housing and education), government administration, and science (research and development). The share of Soviet resources allocated to the service sector has long been relatively small by international standards, possibly partly because the Marxian definition of "productive" economic activity includes only direct contributions to the output of material goods. In turn, the

growth of services in the USSR has been much slower relative to GNP growth than in Western countries.[20]

Nevertheless, the Soviet service sector grew at almost the same rate as total GNP between 1960 and 1986—slower before 1970 and slightly faster afterward (table 3). Rates of increase for services slackened gradually over time but did not fall as markedly as growth in the rest of the economy. Within the service sector, rates of increase for science and for repair and personal care usually have been among the fastest. Education and health services, on the other hand, have grown quite slowly. Housing space also has risen at generally sluggish rates, but availability of utilities has improved markedly.

Aided by a rising share of investment, both transportation and communications grew faster than total GNP during the 1960s and 1970s. Rates of increase have slowed since 1960 in both sectors, but the slowdown was much sharper for transportation than for communications. As a result, transportation's lead on GNP growth has narrowed in the 1980s.

An important source of the transport bottlenecks referred to earlier was inadequate investment in expansion and technical improvement of the rail network. Mistakes were also made in allocating investment. These included an overemphasis on the building of new lines and double-tracking of existing ones and a neglect of yard capacities and terminals. In addition, production of rolling stock was inadequate. Despite continuing strains on capacity, however, railroad performance improved markedly after the appointment of a new rail minister in 1983. Under his stewardship, the use of longer, heavier trains became more common, and this reduced congestion on crowded lines and eased the flow of supplies to industrial producers.[21]

The other major sectors of origin are trade and construction. The trade sector includes a large retail network, so its patterns of growth are roughly similar to those for consumption of goods, and the construction sector is a major component of investment. Therefore, trade and construction are more usefully discussed in the following section on end uses of GNP.

Trends in Major End Uses

As GNP growth slowed in the USSR, so did growth of allocations to all major claimants: investment, defense, and consumption. Planners' priorities for these end uses as reflected in their shares of GNP at current factor cost, however, have not changed much since 1960.[22] Although real growth of investment fluctuated more from year to year than did consumption growth, investment increased more rapidly than consumption in all five-year plan periods except 1966–70. As a result, investment's share of GNP rose

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[20] See the paper by Gertrude E. Schroeder, "USSR: Toward the Service Economy at a Snail's Pace," in this volume, for a discussion of the service sector.

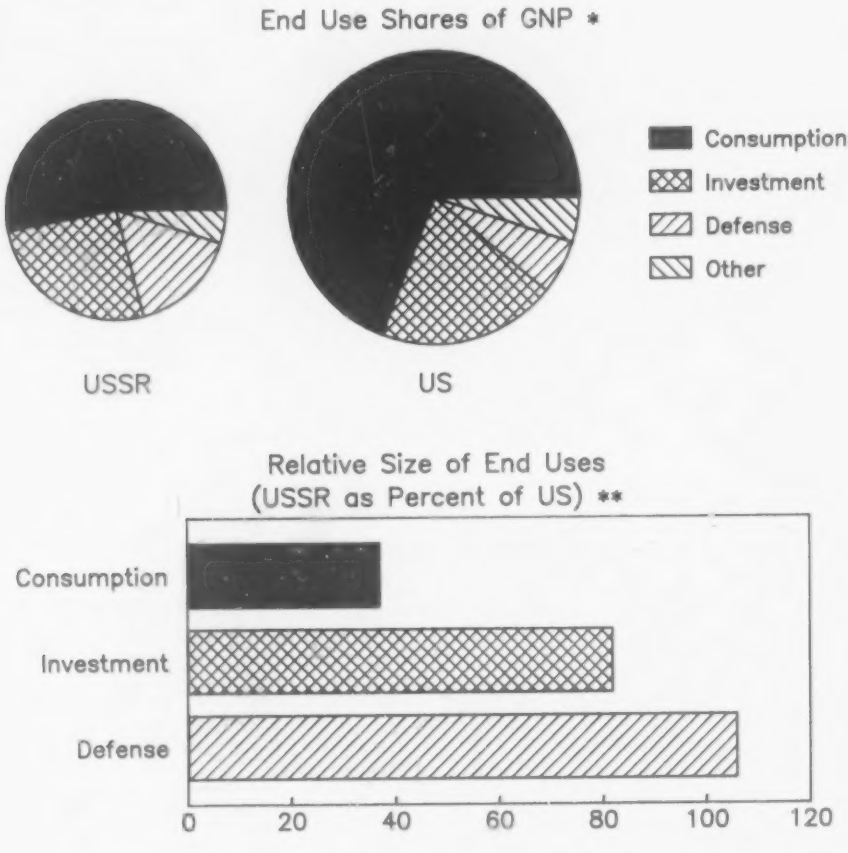
[21] For a discussion of transportation with special attention to railroads, see Holland Hunter and Vladimir Kontorovich, "Transport Pressures and Potentials," in this volume.

[22] Shares for this illustration of priorities are calculated from current values of GNP because changes in both prices and quantities affect decisions about spending. Factor cost values are used because established prices do not give an accurate picture of the costs of economic resources.

slightly, while consumption's share fell a little. The share of defense spending in GNP at current factor cost also rose slightly, partly because real growth of weapons procurement was rapid during the 1960s and partly because costs of military output increased faster than those of civilian production after 1970.

Figure 6

USSR–US: Comparison of End Uses of GNP, 1986



* Based on current domestic values of GNP at factor cost for the USSR and in market prices for the US.

** Based on the geometric mean of a comparison using dollar price weights and another comparison using ruble price weights––except for defense, which is based only on dollar price weights.

Soviet planners traditionally have given lower priority to consumption than to investment and defense, the sources of future output growth and military power, respectively. These priorities

are illustrated by sharp differences between the USSR and the United States in patterns and levels of resource allocation (figure 6):

—Consumption is given a substantially smaller share of GNP in the USSR than in the United States, while investment takes up a larger share and defense a much larger share.[23]

—Soviet consumption is much smaller relative to US consumption than is Soviet investment relative to US investment. Levels of defense spending are roughly equal in the two countries.[24]

INVESTMENT

Investment in the USSR was 3½ times as large in 1986 as in 1960 (figure 7). After 1975, however, planners took a new approach (discussed above) and deemphasized investment.[25] Annual rates of increase slowed as a result, from an average of 5.7 percent through 1975 to 4.0 percent afterwards. Gorbachev has said that this deemphasis was a mistake, however, and in 1986 investment grew by about 6 percent in support of his program to modernize the USSR's industrial base.

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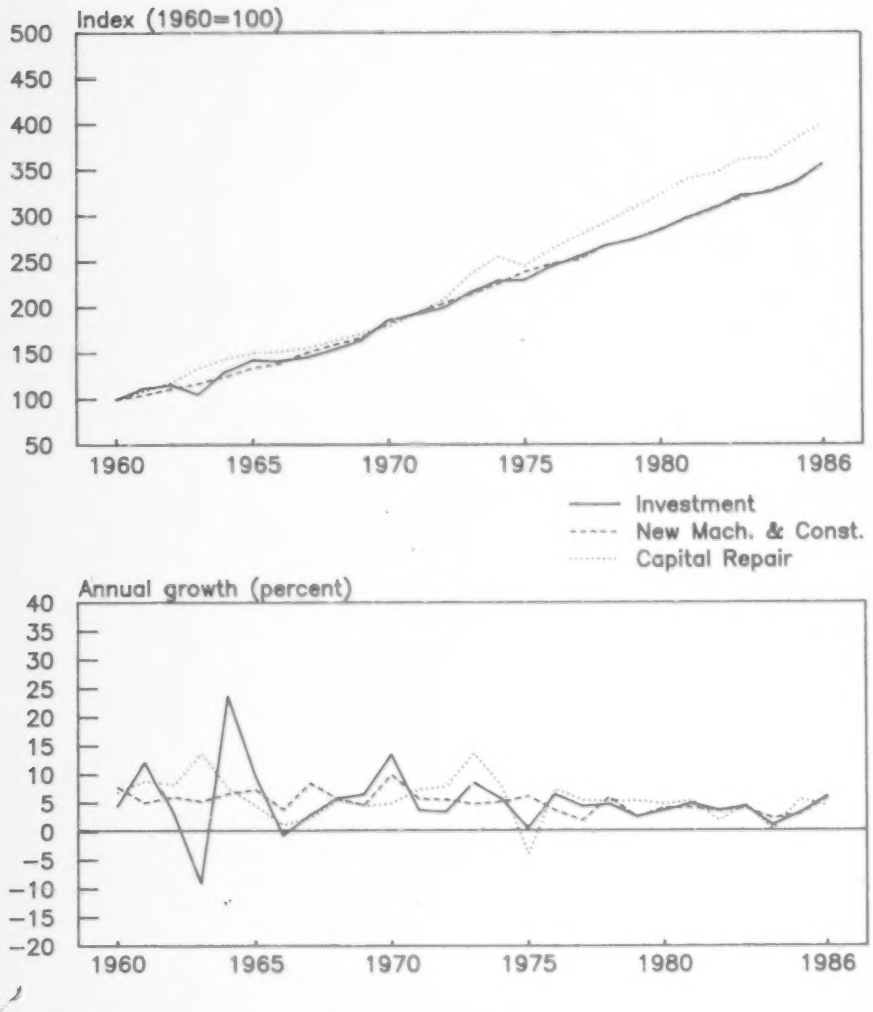
[23] These shares are based on current domestic values of GNP in 1985, at factor cost for the USSR and in market prices for the United States. Estimates by category of end use are adjusted to make coverage comparable between the two countries.

[24] Except for defense, these relative levels represent the geometric mean of a comparison using US prices (dollars) as weights and another comparison using Soviet price weights (rubles). The comparison of defense spending is based only on US price weights because ruble prices are very difficult to estimate for US defense activities—especially weapons production.

[25] For a discussion of investment policy, see Robert Leggett, "Investment Policy in the 12th Five Year Plan," in this volume.

Figure 7

USSR: Trends in Investment, 1960–1986 *



* Based on estimates at 1982 factor cost

Machinery for new investment grew consistently faster than new construction, both before and after investment growth slowed (table 8). Nevertheless, growth of the machinery component of investment declined markedly when rates of increase in domestic output fell in the mid-1970s. Machinery imports cushioned the impact on investment of shortfalls in domestic production, however.

TABLE 8.—USSR: GROWTH OF INVESTMENT BY CATEGORY, 1961–85[1]

(Average annual rates in percent)

	1961–65	1966–70	1971–75	1976–80	1981–85
New fixed investment	7.0	5.9	3.8	3.9	3.4
New machinery and equipment	10.4	7.6	8.7	6.5	4.6
New construction and other	4.7	6.0	4.0	2.0	2.6
Net additions to livestock	25.2	−.8	(2)	(2)	(2)
Capital repair	8.5	3.6	6.4	5.6	3.5
Total investment	7.3	5.5	4.3	4.3	3.4

[1] Based on estimates of end use at 1982 factor cost.

[2] Growth cannot be calculated because the estimated value at the beginning or the end of the period is negative. The effects of changes in livestock are included, however, in estimates of growth of new fixed investment and total investment. As a result, these larger categories of investment show an abrupt slowdown of growth in 1971–75, when poor harvests led to distress slaughtering of livestock. (In contrast, official Soviet investment statistics, which exclude livestock, do not show markedly slower growth until 1976–80.)

For years Soviet leaders have been exhorting the contruction sector to reduce the time required to put new capacity into service. Some progress was made during the early 1980s in reducing the chronic backlog of unfinished construction projects, but the sector's performance continues to be lackluster.

As growth of new investment fell in the late 1970s, growth of capital repair slowed as well, but less markedly. Rates of increase in capital repair, as a result, exceeded those for new investment (excluding livestock). These trends are clearly reflected in Soviet press reports and journal articles bemoaning the larger and expanding volume of repair needed to keep aging plant and equipment in operation:

> Today expenditures on capital repair of machinery and equipment are 2–3 times the initial value. They are effective only if they do not exceed 25 percent of the value. . . . In 1984, 35 billion rubles and almost a fifth of ferrous metals were spent on repair of productive capital stocks. A fourth of the country's stock of machine tools and 6 million workers are employed in repair shops.[26]
>
> Obsolete machinery and equipment that have accumulated in existing capital stocks are diverting labor and material resources in greater and greater amounts and reducing the efficiency of production. According to statistical data, in 1973–82 the share of metal-cutting machine tools and forging-pressing equipment more than 20 years old increased. In industry, fixed productive capital in service more than 20 years rose from 8 to 18 percent.[27]

DEFENSE

By 1985 the level of Soviet defense spending in constant ruble prices was over 2½ times as high as in 1960. As general economic growth slowed, however, so did real growth of defense spending, from an average of about 5 percent per year between 1965 and 1974 to less than 2 percent annually thereafter. This slowdown reflected primarily the leveling off in procurement of weapons (currently about half of all expenditures on defense) during the late 1970s and early 1980s. Nonetheless, the high level of spending on procurement that had been attained provided the military with large quantities of hardware for both strategic and conventional forces.

Although Soviet military power rose steadily, competition between military and civilian claims on resources intensified as

[26] E.A. Voznesenskiy and S.A. Mukhin, "Ways of Accelerating the Renewal of Fixed Capital," *Finansy SSSR* (No. 7, 1986, p. 16).

[27] A. Malygin, "Renewal of Fixed Productive Capital," *Planovoye khozyaystvo* (No. 7, 1985, p. 31).

growth slowed across the economy. Direct spending on defense took up a slightly larger share of GNP at current factor cost in 1982 than in 1970. In addition, rising shares of key industrial outputs went to defense—including indirect requirements of supporting industries as well as direct military uses.

CONSUMPTION

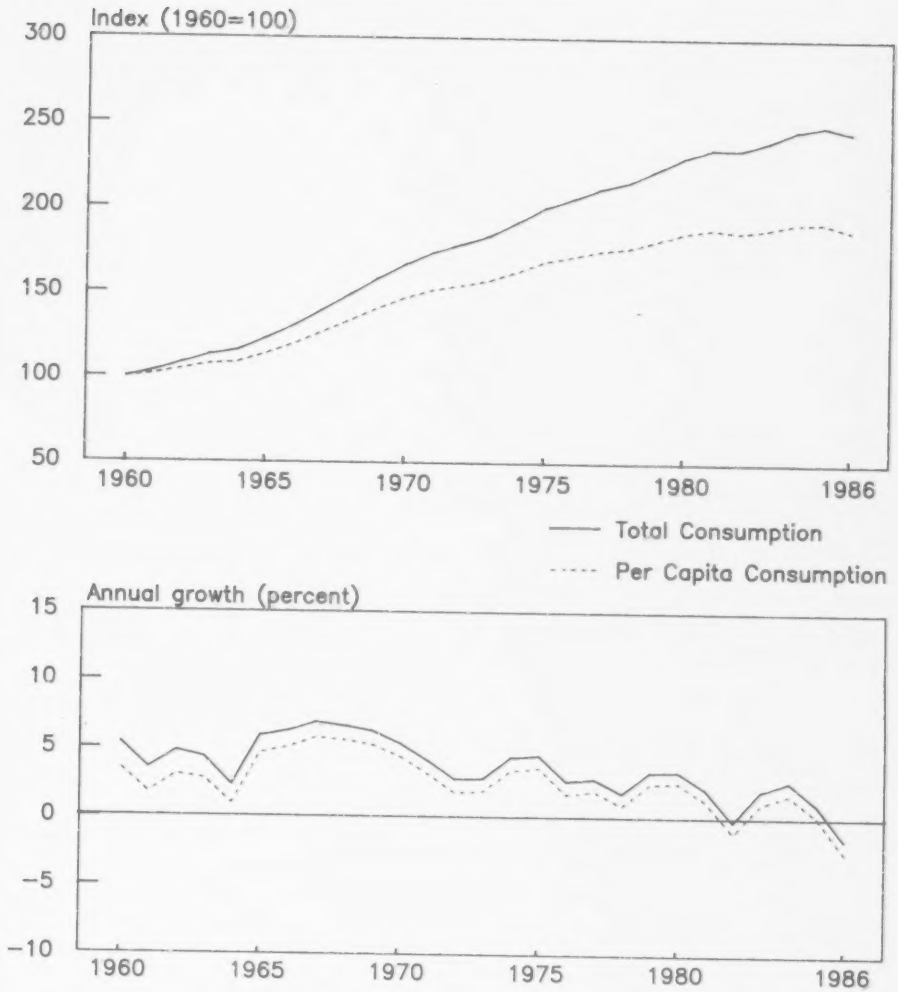
The Soviet population's consumption of goods and services in 1986 was 2½ times as great as in 1960, and consumption per capita almost doubled (figure 8). Growth of consumption slowed along with GNP growth after 1970, however. Annual rates of increase in total consumption slipped from an average of 4.7 percent between 1960 and 1975 to 1.9 percent after 1975, while the corresponding rates for per capita consumption were 3.6 percent and 1.0 percent.[28]

[28] This section is based on estimates of consumption in established prices—because they reflect what consumers pay—rather than the factor cost estimates used in most of the paper. Soviet established prices are clearly inferior to the market prices used to measure consumer welfare in Western economies. Still, they are preferable to factor costs for indicating how many goods and services consumers can purchase with their incomes.

Growth rates of total consumption have been somewhat lower (until the last few years) at factor cost than in established prices because of differences in the weights of various categories of consumption. Several kinds of goods for which consumption has grown rapidly (beverages, soft goods, and durables) have smaller weights at factor cost, and housing, which has grown slowly, has a much larger weight at factor cost.

Figure 8

USSR: Trends in Consumption, 1960–1986 *



* Based on estimates in 1982 factor cost

Trends by category of goods and services

Consumption of goods other than food grew faster than food consumption, as is typical in countries with rising standards of living (table 9). Rates of gain for consumer durables—such as automobiles, appliances, and furniture—exceeded those for soft goods—such as clothing, shoes, soap, and books.

TABLE 9.—USSR: GROWTH OF CONSUMPTION BY CATEGORY, 1961–85 [1]

[Average annual rates in percent]

	1961–65	1966–70	1971–75	1976–80	1981–85
Food	3.5	5.6	2.8	1.8	0.3
Animal products	1.7	5.9	3.2	1.4	1.8
Processed foods	5.8	4.2	2.7	3.5	1.2
Basic foods	1.6	2.0	.6	1.0	1.7
Beverages	7.3	8.5	3.6	2.2	−2.5
Soft goods	3.7	8.3	3.7	3.7	2.2
Durables	5.5	10.6	10.7	6.3	3.9
Services	6.2	5.2	3.9	2.9	2.4
Housing	4.0	3.1	2.6	2.2	2.6
Utilities	9.4	6.5	6.3	4.7	4.2
Personal transportation	10.6	9.3	7.3	3.1	2.5
Personal communications	7.3	8.6	6.4	4.7	3.8
Repair and personal care	6.6	7.5	5.4	5.0	4.0
Recreation	5.2	3.7	5.1	2.1	1.9
Education	6.8	4.1	2.4	2.3	1.5
Health	3.8	4.4	2.4	1.8	1.5
Total consumption	4.2	6.3	3.8	2.8	1.6

[1] Based on estimates of end use in 1982 established prices. Services provided at no charge to users are valued at the cost of the labor and materials used to produce them.

Consumption of food also rose, and the share of animal products in food consumption increased after 1965. Despite these improvements, growth of food consumption continued to be depressed a year or two after a poor harvest. Some of the fastest gains, moreover, were in consumption of alcoholic beverages. Gorbachev's anti-alcohol campaign turned this source of growth into a drag on consumption in 1985–86, and the drag will continue until factories finish converting their production lines from alcohol to other beverages.

Consumption of services increased at somewhat faster rates than consumption of goods during most of the period since 1960.[29] Among the services, personal transportation and communications, repair and personal care, and utilities grew the most rapidly. Growth was slower for housing, education, and health services.

Comparison with other countries

International comparisons of consumption per capita show that the USSR ranks well below the United States and Western Europe, and even below some of its East European allies. Moreover, Soviet consumption differs in composition and quality from that in countries at higher and even at comparable levels of economic development.[30] Food and clothing make up a larger share of total Soviet consumption than in countries with similar levels of GNP per capita. Shares of housing and related services, health care, and personal transportation and communications, on the other hand, are smaller in the USSR.

[29] Consumer policy is discussed in Jennifer Muratore's paper, "Prospects for the Soviet Consumer Under Gorbachev," in this volume.

[30] See Gertrude E. Schroeder's chapter, "Consumption," in Bergson and Levine, eds., *The Soviet Economy*, and her study with Imogene Edwards, *Consumption in the USSR: An International Comparison*, prepared for the Joint Economic Committee of Congress (Washington, U.S. Government Printing Office, 1981).

Although quantitative comparisons of per capita consumption across countries provide reasonably good indicators of relative material well-being, differences in the quality of goods and services are difficult to measure. The comparisons include some adjustments for such differences, but full adjustments for the chronic poor quality and limited variety of Soviet goods would reduce measured consumption in the USSR. Moreover, adjustments for inefficiencies in the Soviet system of distributing goods and services, if they were feasible, would result in a further reduction. Imbalances between supply and demand are chronic, affecting first one product, then another. Some services are rationed—housing is a notable example—and the retail trade network is not designed for the convenience of customers. The illegal and questionably legal activities of the second economy fill in many of the gaps in the official distribution system. Many Soviets, however, find the resulting redistribution of incomes from producers to "arrangers" politically and socially undesirable.

Plans for 1986–90

Gorbachev has made an acceleration of Soviet economic growth a top priority.[31] Plans for 1986–90 imply that increases in GNP are to average roughly 4 percent per year, with industry growing at slightly more than 4½ percent annually.[32] The rates of increase in labor productivity needed to reach these growth targets, however, have not been sustained longer than a year or two since the late 1960s to early 1970s (figure 9).

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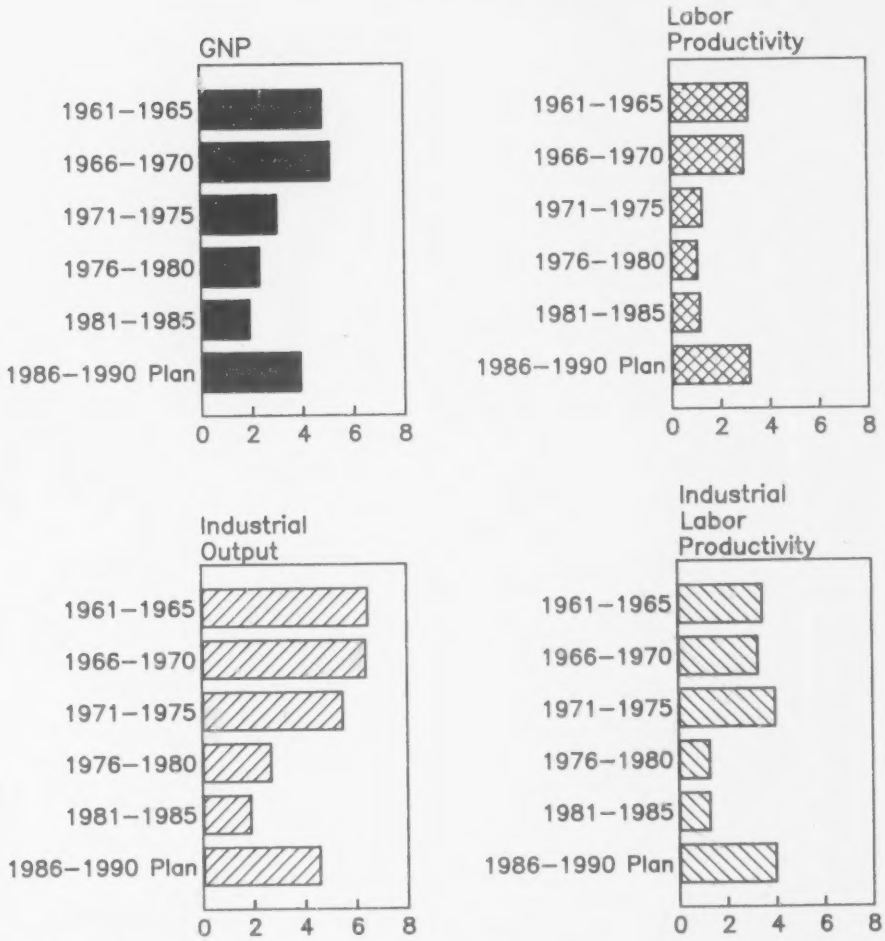
[31] For a discussion of Soviet economic prospects, see Douglas Kreshover's paper, "Gorbachev and the Economy: The Developing Game Plan," in this volume.

[32] GNP growth implied by Soviet plans for 1986–90 is calculated as a weighted average of available official growth rates for industry, agriculture, and other major sectors of origin. The weights are 1985 values of GNP (at 1982 factor cost) in those sectors. Sectoral growth targets are used without adjustment because Soviet plans do not appear to be subject to the disguised inflation that affects official summary statistics on past growth. See CIA Research Paper ER 80–10461, August 1980, *Comparing Planned and Actual Growth of Industrial Output in Centrally Planned Economies*, and James H. Noren and F. Douglas Whitehouse, "Soviet Industry in the 1971–75 Plan," in Joint Economic Committee, Congress of the United States, *Soviet Economic Prospects for the Seventies* (Washington, U.S. Government Printing Office, 1973), pp. 206–245.

Figure 9

USSR: Growth of Output and Labor Productivity, 1960–90

(Average Annual Percentage Rates)



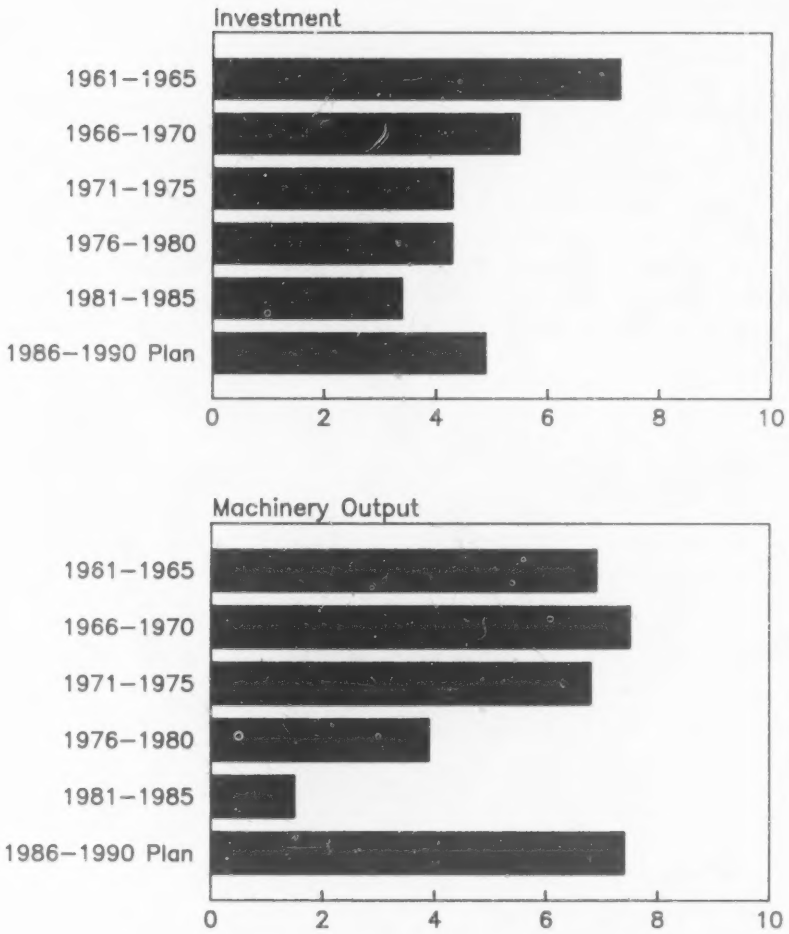
In 1986, GNP grew at about the rate planned for 1986–90—its best showing in a decade. But agriculture's recovery from a poor harvest provided a boost that is unlikely to be sustained, because good results would have to be followed by even better results. Industrial growth was short of target, moreover, although healthy at just over 3 percent. Gorbachev can claim some success in 1986 for his aggressive efforts to accelerate output growth by raising the contribution of "human factors" to productivity. His reinvigoration

of Andropov's campaign to tighten labor discipline and his own attack on alcohol abuse appear to have increased both time spent on the job and output per hour worked. In addition, changes in organization and management—including firings at high levels—probably have removed some bureaucratic obstacles to growth. As measures are taken to reduce sources of slack in production, however, the potential for further gains from such reductions erodes.

Although a program of "radical reform" of the Soviet economic system was approved in June 1987, any major improvements in growth unlikely to be realized until after 1990. During 1986–90, therefore, Gorbachev is hoping to build a lasting base for economic growth by using new machinery to modernize technology and raise productivity, especially in industry. To this end, plans call for investment to increase at an average annual rate of nearly 5 percent—up from 3.4 percent in 1981–85. Machinery output—a major source of investment resources—is to grow by almost 7½ percent per year, a rate not achieved since the early 1970s (figure 10).

Figure 10

USSR: Growth of Investment and Machinery Output, 1960–90
(Average Annual Percentage Rates)



Even if GNP growth reaches its plan-implied target for 1986–90, investment plans are so ambitious that rapid increases in consumption must be deferred. Nonetheless, Gorbachev should be able to supplement his sticks—the discipline and anti-alcohol campaigns—with carrots for consumers, in the form of some improvements in living standards. Shortfalls from planned GNP growth would reduce consumers' gains, however, and substantial shortfalls could lead to cutbacks in planned investment growth. As a result of sub-

stantial investment in defense industries during the 1970s and early 1980s, however, almost all of the production capacity required to support force modernization into the early 1990s is already in place.

By the middle of 1986, Gorbachev was already impatient for signs of rapid increases in both the quantity and the quality of machinery output. Results from late 1986 and early 1987, however, indicated that Soviet machine builders were finding it difficult to pursue his ambitious targets for quantity and quality simultaneously. Many improvements in quality require the introduction of new designs and new production processes, but slow retooling of production lines began drawing official criticism in the latter months of 1986. At the beginning of 1987, moreover, a new system of inspecting output for conformity with quality standards was introduced at 1500 industrial enterprises. Initial rejection rates were especially high for machinery.

Appendix A

Estimates of Soviet GNP in 1982 Prices

This appendix presents a brief overview of the Central Intelligence Agency's estimates of Soviet gross national product (GNP) in 1982 prices—summarizing the methods of estimation and assessing the degree of confidence in the results. Except for the ruble price base, which has been moved forward from 1970 to 1982, the methods of estimation are mostly unchanged from those described in the CIA's benchmark study of Soviet GNP in 1970 prices.[33] The basic outlines of the methods are reviewed below, and changes from earlier procedures are pointed out. Then the quality of the evidence on which the estimates of GNP in 1982 prices are based is compared with that for the previous estimates in 1970 prices. Finally, some key methodological problems of estimating Soviet GNP are noted.

Methods of Estimation

The CIA's methods of estimating Soviet GNP involve two main stages: (1) developing a comprehensive set of estimates for the base year and (2) calculating growth from data on changes in major GNP components (figure A1). For the base-year estimates, coverage of economic activity is as complete as possible, and the measures used correspond as closely as possible to the definitions and concepts used in GNP estimates for Western countries. Data for the growth estimates are not as complete as data for the base year, however, because it is feasible to track changes in output only for samples of products. Moreover, precisely defined measures of many GNP components are made only for the base year, so that proxies must be used to estimate growth. Estimates of industrial growth, for example, are based on changes in output including processed inputs rather than on value added, which is used in estimating industry's contribution to base-year GNP (see the next section).

Figure A1.—*Key steps in estimating Soviet GNP*

Base year	*Growth*
—Complete coverage	—Sample coverage
—Precise definitions of measures	—Proxies for base-year measures

ESTIMATES OF BASE-YEAR GNP

Besides total GNP, base-year estimates are made for components broken down by end use and by sector of origin. The former breakdown shows the distribution of output to final purchasers for uses such as consumption, investment, and defense.

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[33] See Joint Economic Committee, *USSR: Measures.*

Following Western accounting procedures, output is counted only once, when it is sold to final purchasers. Otherwise, products sold from one enterprise to another would be counted several times—for example, as iron ore, rolled steel, and automobile chassis—before reaching final consumers—in this example, as automobiles.

In the breakdown of GNP by sector of origin, income resulting from the production of final output is allocated among sectors such as industry, agriculture, and services. This income consists of value added by primary factors of production like labor and capital. In order to avoid counting products more than once, it excludes the value of processed inputs sold between enterprises.

Base-year estimates of GNP are made initially in Soviet established (official) prices. These prices have several shortcomings that prevent them from reflecting the allocation of economic resources accurately:

—Substantial turnover (excise) taxes are levied on selected products, mainly consumer goods such as automobiles, clothing, and alcohol.

—Subsidies keep prices artificially low for basic consumer needs like bread, meat and dairy products, housing, and some other items.

—Reported profits are distributed unevenly among sectors and set at arbitrary rates during the process of price formation, making them an unreliable indicator of the contribution of capital to production.

Therefore, in an attempt to approximate better the value of resources used in production and allocated to end uses, the CIA applies concepts and procedures pioneered by Abram Bergson to adjust its estimates of Soviet GNP from established prices to factor cost.[34] On the sector of origin side of GNP, where the adjustment begins, the goal is to make value added in each major sector reflect that sector's use of labor and capital resources. Wages in established prices are accepted without adjustment because they are believed to measure returns to labor reasonably well. Data on enterprises' depreciation payments also are accepted, largely because little other information is available to measure wear and tear on capital stocks. But the rest of value added in established prices—turnover taxes, subsidies, and profits—is not a good measure of returns to capital. These elements are subtracted from base-year estimates of value added in established prices, and returns to fixed and working capital—calculated at a uniform rate of 12 percent—are added back. In principle, returns to agricultural land and other natural resources also should be estimated and added to GNP. The CIA is examining the feasibility of developing such estimates.

Next, the effects of the factor cost adjustment on GNP estimates by sector of origin are traced through the production process to the end use side of GNP. Turnover taxes and subsidies that fall directly on specific end uses—such as taxes on alcoholic beverages and subsidies on housing—are removed from those uses. The remaining effects of substituting factor costs for established prices in estimates of value added by sector or origin are calculated with the aid of an input-output table for the base year (1982). For each sector, the table shows linkages from value added by primary inputs to gross output—including processed as well as primary inputs—and then to end uses of gross output. These linkages make it possible to determine not only the direct effects of changes in estimates of value added in, say, metallurgy, but also the indirect effects of such changes on output of machinery and other sectors using metals as inputs.

ESTIMATES OF GNP GROWTH

Base-year estimates of Soviet GNP—both at factor cost and in established prices—are used as weights for estimates of GNP growth. First, growth is estimated for the major components of GNP. In principle, growth of total GNP then can be calculated as a weighted average of growth of the components either by sector of origin or by end use. In practice, however, growth of total GNP is determined by growth estimates for the sectors of origin, which generally give more reliable results (figure A2). The end use side of GNP includes several components for which growth is particularly difficult to estimate: capital repair, exports net of imports, and inventory change. Because of these difficulties, estimates of the growth of the residual category of GNP by end use (outlays not elsewhere classified) would be highly uncertain in any case. Growth of this "end use residual" therefore includes any changes in the

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[34] See Bergson's *Soviet National Income and Product in 1937* (New York, Columbia University Press, 1953), chapters 3–4; Bergson and Hans Heymann, Jr.'s *Soviet National Income and Product, 1940–48* (New York, Columbia University Press, 1954), chapter 3; and Bergson's *The Real Income of Soviet Russian since 1928* (Cambridge, Mass., Harvard University Press, 1961), chapters 3, 8–9.

statistical discrepancy between sector of origin and end use estimates.

FIGURE A2.—*Basis for calculating Soviet GNP growth*

Base-year value	×	*Index of growth*	=	*Value in another year*
Sector 1		Sector 1		Sector 1
+ Sector 2		Sector 2		+ Sector 2
+ Sector 3		Sector 3		+ Sector 3
.....		.....		.....
+ Sector N		Sector N		+ Sector N
Sum = GNP				Sum = GNP

CHANGES IN PROCEDURES FOR ESTIMATES

Although the basic methods used to estimate Soviet GNP in 1982 prices are the same as those used for GNP in 1970 prices, specific procedures for making several parts of the estimates have changed. The first of these changes is that the factor cost adjustment of estimates for the new base year follows a revised procedure. In addition, estimates of growth for the following sectors of origin are based on new procedures or information, or both:

—Repair and personal care.
—Recreation.

The key change in the *factor cost adjustment* is in calculating the returns to capital that are added to GNP after turnover taxes, subsidies, and profits are removed. For base-year estimates of GNP in 1970, the total value of returns to capital was assumed equal to the sum of the elements removed from GNP. In estimating GNP for 1982, however, returns to capital are assumed to be 12 percent of the value of the stock of fixed and working capital, with fixed capital estimated net of depreciation.[35] Valuing capital net of depreciation also involves a change from estimates of 1970 GNP at factor cost. Previously, returns to capital were distributed among the sectors of origin in proportion to sectoral capital stocks including depreciation. Because some sectors have older stocks than other sectors, however, the assumption that the rate of return to capital is uniform for all sectors is not strictly valid if depreciation is included. In the present factor cost adjustment, therefore, the distribution of returns to capital is proportional to stocks excluding depreciation.

The *repair and personal care* sector includes both state-administered and privately provided services such as laundry, dry cleaning, barber and beauty shops, and repair of household appliances, automobiles, and housing. Very little information is available on the private component of the sector, and the information that is available is subject to ambiguities in both coverage and valuation. Because of the lack of data, growth of these private services in 1982 prices is assumed constant at 1 percent per year on a per capital basis. Estimates of their growth in 1970 prices, in contrast, were based on scattered—and probably inconsistent—observations for a few years. (Growth of state services in prices of both 1982 and 1970 is based on official Soviet data on the services' value in prices that the Soviets claim to be constant.)

Estimates of the growth of *recreation* services in 1982 prices are based on new information, including a revised sample of services provided by that sector. For the resorts and leisure component of recreation, estimates of growth in 1982 prices are combined, instead of being made separately, as in 1970 prices. Moreover, the sample of services used to estimate growth for the new, combined category adds data on the number of persons using rest bases and tourist hotels to earlier data on persons using sanatoria, resorts, and rest homes. Data on hotel use (with employment in hotels serving as a proxy for the number of persons accommodated) have been

[35] The assumed rate of return is that set by Soviet planners for deciding among alternative investment projects. See Gosplan SSSR, *Metodicheskiye ukazaniya k razrabotke gosudarstvennykh planov ekonomicheskogo i sotsial'nogo razvitiya SSSR*, (Moscow, Ekonomika, 1980), p. 441.

In removing depreciation from values of fixed capital stock, it is assumed that wear and tear constituted the same share of 1982 values including depreciation as at the time of the last complete revaluation and inventory of capital in 1972. Shares of wear and tear are published for the economy as a whole and for selected major sectors in Tsentral'noye statisticheskoye upravleniye pri Sovete Ministrov SSSR, *Narodnoye khozyaystvo SSSR v 1972 g.* (Moscow, Statistika, 1973), p. 63.

dropped from the sample. (Growth of the entertainment component of recreation is estimated, as before, from data on paid attendance at movies and theaters.)

Confidence in Estimates

The degree of confidence that can be placed in the CIA's estimates of Soviet GNP depends, to an important extent, on the results of moving the price base forward from 1970 to 1982. In general, the quality of the evidence for the new estimates in 1982 prices is considered to be satisfactory, although probably not as good as that for the estimates in 1970 prices. Regardless of the price base used, moreover, GNP estimates are subject to uncertainties arising from general methodological problems. Research on some of these problems is underway—inside and outside the CIA—but in most cases, no easy solutions are available.

MOVE TO 1982 PRICE BASE

Shifting the price base for Soviet GNP requires a new set of base-year estimates for the major GNP components—by sector of origin and by end use—both in established prices and at factor cost. In addition, weights need to be estimated in further detail for the individual products and groups of products used to track GNP growth. The confidence attached to these estimates of major components and more detailed weights varies with the kinds of information on which they are based.

Estimates of the major components of 1982 GNP in established prices are thought to be fairly reliable. Many are based directly on data published in official Soviet statistical sources. Information on some of the components—especially privately provided services and budgetary incomes—is more difficult to find, however. Often it must be pieced together from Soviet monographs and journal articles.

Although the factor cost adjustment yields better estimates of the costs of economic resources than Soviet established prices do, some of the procedures used for the 1982 adjustment are based on considerably less information than those for 1970. Data for the adjustment of 1982 GNP by sector of origin are similar in quality to 1970 data. The adjustment of end use estimates for 1982, however, is based on a less detailed input-output table—which is derived from much less information—than the table used for the 1970 adjustment.

Detailed weights for estimates of GNP growth in 1982 prices appear satisfactory for the most part, but less so than for 1970. Most of the official handbooks listing prices for 1970 (and years close to it) are not available for 1982 prices. The vast majority of the 1982 prices used for individual products come from Soviet monographs and journal articles; price information is especially sparse for chemicals and processed foods.

Weights used in estimating growth of certain groups of products also must be derived for 1982—within branches of industry (for example, precision instruments and automobiles within machine building) for GNP by sector of origin, and within consumption (for example, meat and milk products within food consumption) for GNP by end use. Information on which to base the 1982 weights within industry is clearly inferior to that for 1970, because it comes from a less detailed input-output table. Data for the subcategories of consumption, however, are fairly good—drawn largely from official Soviet statistical sources.

GENERAL PROBLEMS OF ESTIMATION

Problems of selecting and refining methods of estimation are common to all countries that compile GNP statistics and similar summary measures of economic activity. For Western efforts to estimate Soviet GNP, many of the problems are exacerbated by the USSR's traditional reluctance to divulge information about its economy. Despite the recent release of some additional information under Gorbachev's policy of *glasnost* (openness), far fewer economic statistics are available for the USSR than for Western countries.

Contribution of Second Economy to GNP. The "second economy" in the USSR includes a variety of private and illegal or questionably legal activities, some of which contribute to GNP while others do not. Its full scope—according to Gregory Grossman's standard definition—is broad: [36]

> As some scholars define it, the second economy comprises all production and exchange activity that fulfills at least *one* of the two following tests: (a)

[36] Grossman, "The 'Second Economy'," p. 25.

> being directly for private gain; (b) being in some significant respect in knowing contravention of existing law.

Two kinds of problems arise in measuring the second economy's contribution to Soviet GNP: determining which of its activities should be included and estimating the value of those activities. In principle, Soviet GNP should cover the full range of economic activities measured in GNP statistics for Western countries. This standard calls for the inclusion of all legal private production and also of activities that are illegal or tightly restricted in the USSR but not in the West. Before the recent revisions of Soviet laws governing private activities, for example, carpentry and watch repair were legal—provided that individuals performing the services registered with the state, paid taxes, and used no stolen materials—while taxi services were illegal. In addition, GNP should include any increases in output available to final purchasers as a result of the diversion of state resources—such as the construction of private housing using materials stolen from state enterprises.

Nonetheless, Soviet GNP should exclude, as Western statistics do, activities that would be considered crimes in any country. These exclusions would cover: [37]

> Theft from individuals for personal use or sale, prostitution, murder or mayhem for hire, bribery of public officials to obtain personal favors (e.g., admission to a university), and embezzlement of state funds.

More generally, activities that do not add to legal production of goods and services for final use should be excluded from GNP. For example, black-market transactions in goods purchased from state retail stores for resale at sharply increased prices should not be counted. Retail sales—valued at prices established by the government—are already included, and any services provided by black marketeers in selling goods at more convenient times and places would be illegal in the United States as well as in the USSR.[38] It is often difficult, however, to draw a line between "illegitimate" resale of goods in short supply at exaggerated prices and diversion of state resources to "legitimate" private uses that add to GNP.

At present, the CIA's estimates of Soviet GNP in the base year (1982) include many activities of the second economy, but problems of acquiring the necessary data prevent full coverage of such activities. The Soviet statistical system is oriented primarily toward measuring production of goods in the state-administered economy. To the extent that they are based on official Soviet statistics, the CIA's estimates of GNP have similar uncertainities in measurement of privately provided goods, and especially services. Research directed by Gregory Grossman and Vladimir Treml is under way, however, that may improve measurement of the second economy's contribution to base-year Soviet GNP.[39]

Legal private production in agriculture and housing is included in the official Soviet statistics used to estimate the contribution of these sectors to base-year GNP. Some undercounting of this production in GNP estimates is possible if there are gaps in the official data, but the magnitude of any undercounting probably is small. On the other hand, most illegal private production is not captured in the CIA's estimates of Soviet GNP. The largest item in this category probably is home-distilled liquor, but because its production is illegal in the West, as well as in the USSR, it should not be included in GNP estimates.

Base-year estimates of GNP also include a wide variety of privately provided services, without distinction as to which are classified as legal or illegal by the Soviets. Estimates for the repair and personal services component are based on information from Soviet monographs and press and journal articles. Although the coverage of the Soviet data is not described clearly, it probably corresponds reasonably well to that of the GNP component. The contribution of some other private services to GNP is undercounted, however. Estimates of privately provided health and education

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[37] Schroeder and Greenslade, "On the Measurement," p. 5.

[38] See George Jaszi, "The Conceptual Basis of the Accounts: A Rexamination," in Conference on Research in Income and Wealth, *A Critique of the United States Income and Product Accounts*, Studies in Income and Wealth, Vol. 22 (Princeton University Press, 1958), p. 143.

In explaining the exclusion of illegal activities from U.S. measures of GNP, Edward Denison specifies that "The value of products that are illegal, at least in the uses to which they are put, is to be excluded." He adds, however, that "Legal products are to be included even if their producers evade taxes, or ignore the minimum wage, the Sherman Act, and other legislation, or are illegal immigrants, gangsters, or escaped convicts." See his article, "Is U.S. Growth Understated Because of the Underground Economy? Employment Ratios Suggest Not," *Review of Income and Wealth* (March 1982, pp. 1-16).

[39] The results of this research are being published in a series titled *Berkeley-Duke Occasional Papers on the Second Economy in the USSR*.

services are based on very little information, and a lack of data prevents estimates of private transportation services (such as taxi services provided in private automobiles).

GNP estimates for the base year include some private activities involving the diversion of state resources but exclude others. Private housing built with materials stolen from state enterprises, for instance, is included in GNP estimates to whatever (unknown) extent it is covered in official Soviet investment statistics. Most illegal production—using stolen as well as purchased materials—of consumer goods probably is not counted in GNP, however. Such production is included if it is sold through state retail outlets and counted in their sales, but most of it probably is sold privately.

The lack of data on the second economy probably has a greater impact on estimates of Soviet GNP than it has on the GNP estimates of Western countries. The scope of the second economy (excluding criminal activities) probably is broader in the USSR—where it partially fills the gaps and remedies the shortages left by state-administered activities—than it is in the West. As difficult as it is to measure the contribution of the second economy to Soviet GNP for a single year, moreover, obtaining reliable estimates of the growth of these activities is impossible, given the information available. Problems of measuring the second economy's contribution to GNP are not unique to the USSR however. In the United States, for example, a variety of small-scale services, such as repair of consumer goods, are undercounted in GNP when the providers of these services do not report their incomes to the Internal Revenue Service.

Contribution of Foreign Trade to GNP. The CIA is reexamining its estimates of the base-year contribution of foreign trade to Soviet GNP. Base-year estimates of GNP in established prices presently include exports and imports valued in world prices and converted to domestic currency at official exchange rates. The effects of valuing exports in domestic prices instead are being analyzed.

Strictly speaking, the present "GNP" estimates measure gross domestic product (GDP) rather than gross national product, but the feasibility of developing estimates of GNP "proper" is being studied. Differences between GNP and GDP reflect differences in the coverage of payments for labor and capital services exchanged between countries, or "net factor incomes from abroad." Because the Soviet government places tight controls on all incomes of this kind, however, differences between GDP and GNP are undoubtedly small.[40]

In addition to its reexamination of estimates of foreign trade for the base year, the CIA is working on an alternative measure of the impact of trade on overall Soviet economic growth. For the United States, the Bureau of Economic Analysis estimates growth of the volume of goods and services over which the country has "command" as a result of its current production. Growth of command differs from the usual, production-based measure of GNP when the relationship between export prices and import prices changes. Rough estimates of growth of command are being tested for the USSR.

Sources of Over- and Underestimation of GNP Growth. Growth of some components of Soviet GNP probably is understated by the CIA's estimates, while growth of others most likely is overstated. Similar problems of estimation, of course, are faced by statistical agencies in all countries. In the Soviet case, the direction of error for a particular component of GNP depends primarily on the data in the sample used to estimate the component's growth. These data are of two kinds:

- —Data on quantities of output in physical units—such as tons, items, or square meters—which are multiplied by prices of the base year (1982) to obtain values. Sources for the quantity data consist of official Soviet statistical publications, supplemented by analyst estimates.
- —Data on values of output in "constant" prices established by the Soviet government, which are taken directly from official Soviet sources. Most of the products covered by these data—such as computers and furniture—are so numerous and varied that estimates of output in physical units are not feasible.

Both kinds of data have shortcomings. Most quantity data do not reflect the full extent of improvements in product mix and quality—including the introduction of new products as an extreme case—that accompany economic growth. The root of the problem is that measures in physical units show trends in output accurately only for narrow categories of similar products. Quantity data detailed enough that only

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[40] To estimate GNP for the USSR, payments to Soviet nationals (and the government) of wages and salaries earned abroad and of returns to capital invested abroad must be added to GDP. Similarly, payments to foreign nationals of wages, salaries, and returns to capital earned inside the USSR's borders must be subtracted.

similar products are combined, but still comprehensive enough that coverage is adequate, are seldom available.

Unlike quantity data, value data do reflect improvements in product mix and quality, including the introduction of new products. Soviet value data, however, are reported in prices described in official sources as constant but criticized by almost all Western specialists—and a number of Soviet researchers—for including a substantial degree of disguised inflation. Essentially, the problem is that producers benefit financially from making minor alterations in familiar products and using the "improvements" as an excuse for raising prices. Even products incorporating genuine improvements, moreover, are valued at prices set to cover the high initial costs of the early stages of production. The producers can not only charge their customers higher current prices for the new products, but they also can use new, higher constant prices in reporting their output to the planning and statistical authorities.

On balance, improvements in the mix and quality of products probably are understated a little in the CIA's estimates of the growth of Soviet GNP. Tendencies toward over- and underestimation appear to balance fairly evenly for most of the major sectors of origin. Within industry, it is likely that some overstatement of the growth in machinery output—where samples are based largely on value data—roughly offsets the understatement of growth in other industries—primarily chemicals and, to a lesser extent, construction materials—where samples are based mostly on quantity data.

Growth of the service sector of Soviet GNP probably is understated, but not by much. The procedures used to estimate the growth of housing and of government administration and related services are the main sources of understatement. Housing growth is estimated by using data on changes in living space—which do not reflect improvements in quality—as a proxy for changes in value added. For a number of other services—education, health, credit and insurance, and government administration—growth of labor inputs is used as a proxy for growth of value added. This procedure assumes that labor productivity has been constant. Although labor productivity probably has risen, little information is available for estimating the rate of increase.

Most Western countries also use growth of labor inputs as a proxy for growth of value added in some government services. In estimating Soviet GNP growth, however, the CIA uses this proxy more frequently than Western countries do, because fewer alternative data are available. Moreover, data on the labor component of government and related services in the USSR are often less detailed than for the West, so that fewer improvements in the mix of skills of the work force are reflected. Despite these data problems, the CIA is exploring possible methods of improving its treatment of rising quality and productivity in the service sector.

Several recent articles in the Soviet and Western press have called attention to sources of likely overstatement in official Soviet statistics on economic growth. The Soviet articles have been concerned mainly with disguised inflation in official statistics on the value of output—especially in the machinery and construction sectors—in supposedly constant prices.[41] Although *glasnost* has given this problem increased visibility, Western economists and some Soviet researchers have been aware of disguised inflation for years. As discussed above, the CIA's estimates of Soviet economic growth make extensive use of quantity data in an effort to minimize the problem's impact.

The Western articles on Soviet statistics have focused mainly on the likelihood of an unusually large overstatement of official summary measures of growth in 1985 and 1986.[42] CIA analysts also believe that these official figures are more overstated than usual. But the CIA's independent estimates of Soviet GNP growth, which are based on more detailed data, are not affected by recent difficulties with the official summary statistics.

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[41] See V. Selyunin and G. Khanin, "Cunning Figures," *Novyy mir* (No. 2, 1987, pp. 181-201) and A. Sergeyev, "The Prestige of the Honest Ruble," *Sovetskaya Rossiya*, (18 Mar. 1987).

[42] See Jan Vanous, "Soviet Economic Performance in 1986: Modest Improvement Clouded by the Release of Key Aggregate Economic Indicators Conflicting With Each Other," *PlanEcon Report* (4 Feb. 1987); and "The Dark Side of 'Glasnost': Unbelievable National Income Statistics in the Gorbachev Era," *PlanEcon Report* (13 Feb. 1987). Also see Philip Hanson, "Puzzles in the 1985 Statistics," *Radio Liberty Research Bulletin*, RL 439/86 (20 Nov. 1986); and "The Plan Fulfillment Report for 1986: A Sideways Look at the Statistics," *Radio Liberty Research Bulletin*, RL 76/87 (Feb. 26, 1987).

DEMOGRAPHIC TRENDS IN THE SOVIET UNION

By W. Ward Kingkade*

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I. Summary

This paper profiles recent and prospective trends in the size and composition of the Soviet population. Census Bureau projections of the population of the USSR by republic and by major nationality are presented. Current Soviet population policy initiatives are discussed.

The 1980's are distinguished from the preceding part of the postwar period by an abrupt reduction in the growth of the working age population to negligible proportions. Non-European nationalities are responsible for the growth that is occurring. Despite recent shifts in fertility, which has risen among Europeans while declining among Central Asians, non-European nationalities will continue to dominate population growth over the foreseeable future. Reductions in mortality have been registered in the young adult ages where accidents are a leading cause of death. Mortality has continued to increase over age 50.

II. Introduction

A period of sharply diminished growth in population and labor resources began in the USSR in the 1980's. The increases in the total and able-bodied populations projected for the remainder of

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this century are minimal in comparison to those experienced in the postwar period up to 1980. Economic growth under these circumstances must be achieved through increases in labor productivity rather than by the traditional means of expanding employment. Aware of this implication, Soviet economic policy is focusing increasing attention on the "human factor" of labor quality. This has been reflected by the adoption of a series of demographic policy measures aimed at stimulating population growth and improving the health of the Soviet population.

Imbalances in growth among republics and nationalities are a crucial feature of the USSR's current population problems. In the European republics where most Soviet industry is concentrated the able-bodied populations are declining, while explosive population growth characterizes the Central Asian population. The predominantly rural background and limited fluency in Russian of the native population of Central Asia diminish its potential as a reserve of additional industrial labor. Outmigration from Central Asia has yet to occur on a major scale. At the same time, the rapid growth of the Central Asian population calls for expansion of eductional facilities if the existing differentials are not to be execerbated, implying demands on scarce investment funds.

In apparent response to the emerging deficit of new entrants to the labor force in the 1980's the 26th Party Congress adopted a set of pronatalist incentives centering on partially paid maternity leave for working women.[1] Since then fertility has risen, particularly in the European republics where female labor force participation rates are highest. The shift in fertility will begin to impact the working age population in the late 1990's.

Trends in mortality exercise a more immediate effect on the size of the adult population. The anti-alcoholism campaign begun shortly after Gorbachev's promotion to General Secretary has been cited as the cause of recent mortality declines in the Soviet press. Experiments in extending the coverage of clinical health services are also underway.

III. Recent and Prospective Population Trends

TOTAL POPULATION

Postwar trends in the total and working age populations are presented in table 1. During this period the pace of population growth has fallen from a high of 1.7 to 1.8 percent in the 1950's to roughly half that value at present, largely as a result of the declining level of Soviet fertility. Over the remainder of the century population growth is expected to slacken slightly further. Although the working age population has grown more erratically, a longterm slowdown is evident. The projected growth of the working age population from 1980 to 2000 is less than that estimated for the 1970's alone.

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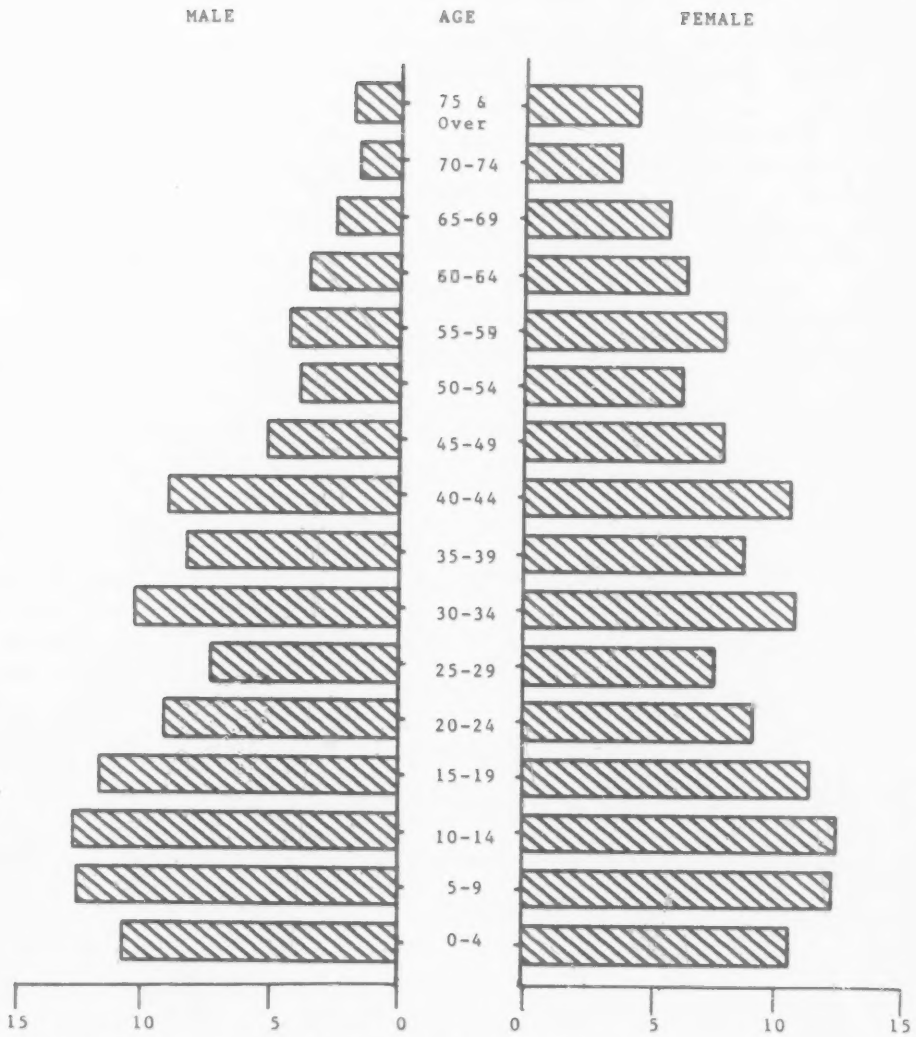
[1] Postanovleniye TsK KPSS i Soveta Ministrow SSSR, "O Merakh po usileniyu gosudarstvennoy pomoshchi semyam imeyushchim detey," in *KPSS v Resolyutsiyakh i resheniyakh syezdov, konferentsy i plenumov TsK*, 14, 1980–1981, pp. 124–132. (Hereafter referred to as "Postanovleniye," 1981a.)

The striking contrast between the impressive growth of the able-bodied population in the 1970's and its abrupt curtailment in the 1980's is a demographic aftereffect of such major historical events as the two world wars and the civil war. Figures 1–3 illustrate the changing age composition of the Soviet population over the recent past. In 1970 the population age 5–14, whose members entered the working ages in the ensuing decade, outnumbered the population then in the young working ages (see figure 1). At the same time the population in the peak reproductive ages (20–29) comprised survivors of the relatively small numbers of births during the second world war and the immediate postwar years, leading to fewer births in the late 1960's to early 1970's than in preceding years. The survivors of these births reach the working ages in the 1980's, producing a decline in the number of new entrants to the able-bodied population as illustrated in figure 3. The 1980's also witness an increase in the number of exits from the working ages into the pension ages, reflecting increases in births during the NEP period.

Over the foreseeable future the Soviet population is expected to acquire a more elderly age distribution as a result of the longterm decline in fertility (see figure 4). By the year 2000 the pension age population will be comprised primarily of persons born during or after the NEP whose childbearing occurred under the low postwar fertility levels of 2–3 children per couple. For this reason the elderly at the end of this century will be less outnumbered by their descendants than has been the case in preceding generations.

Figure 1.

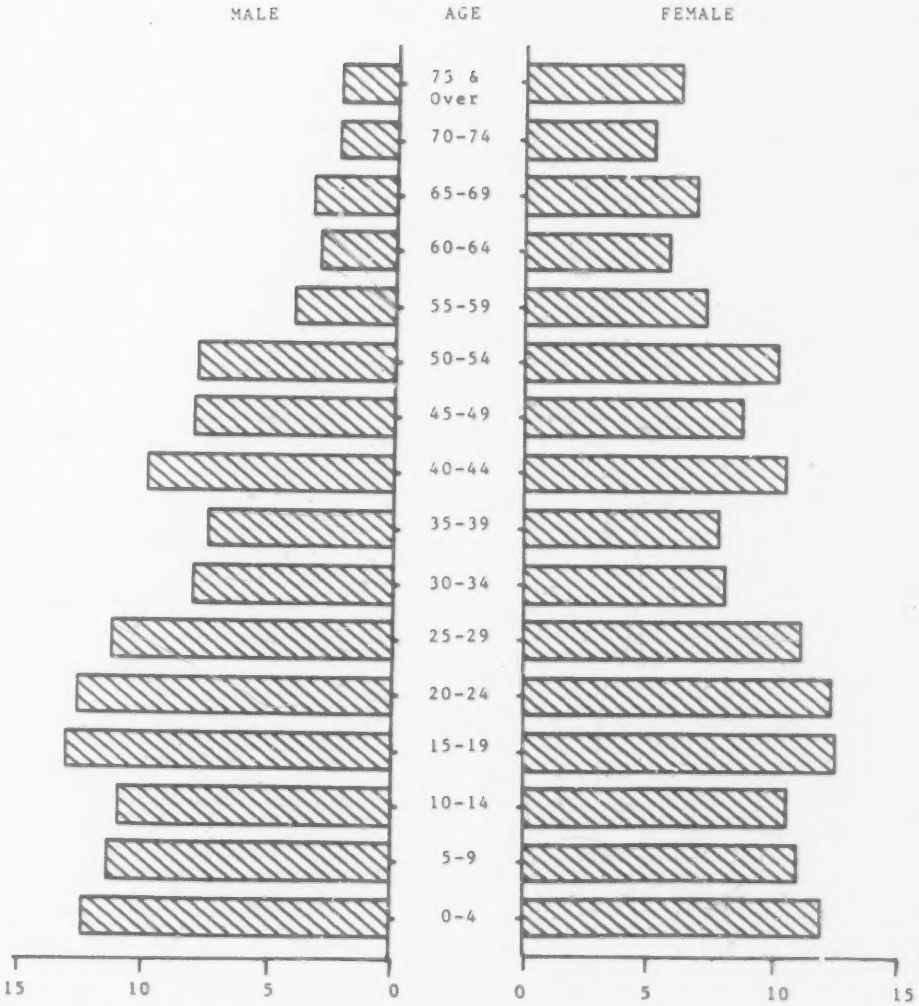
AGE - SEX PYRAMID 1970



Source: US Census Bureau Estimates and Projections.

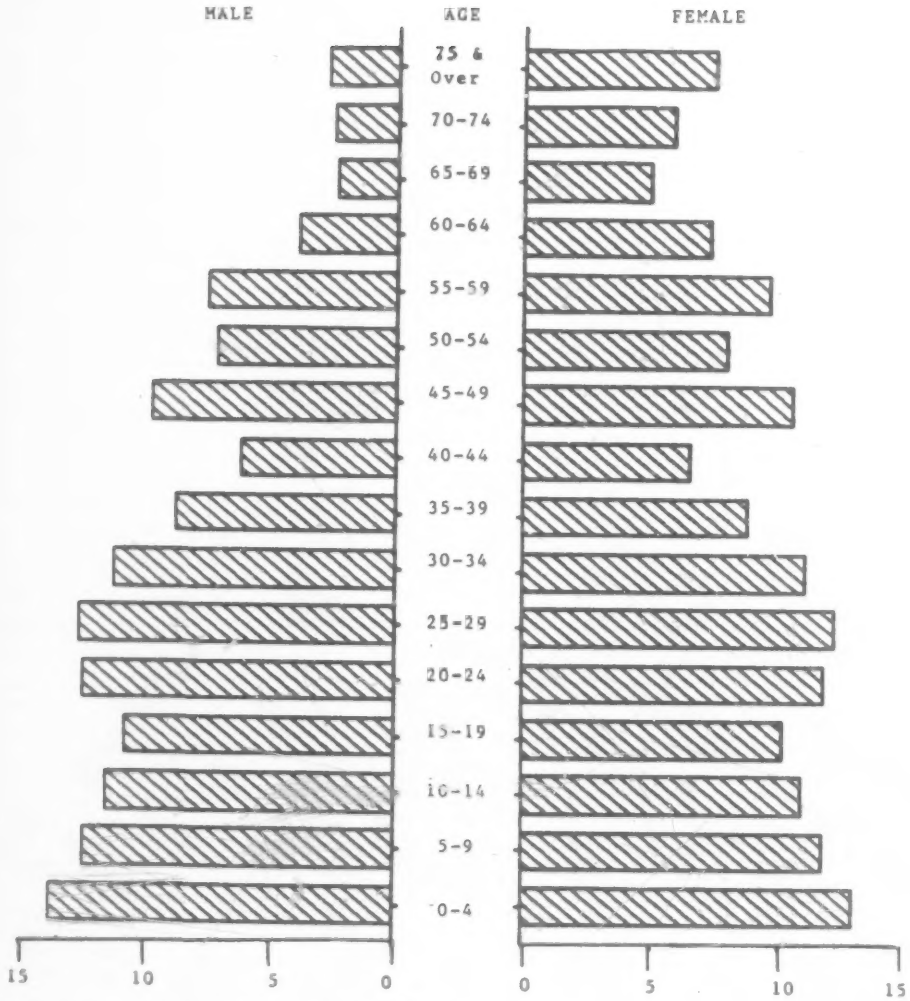
Figure 2.

AGE - SEX PYRAMID 1979



Source: US Census Bureau Estimates and Projections.

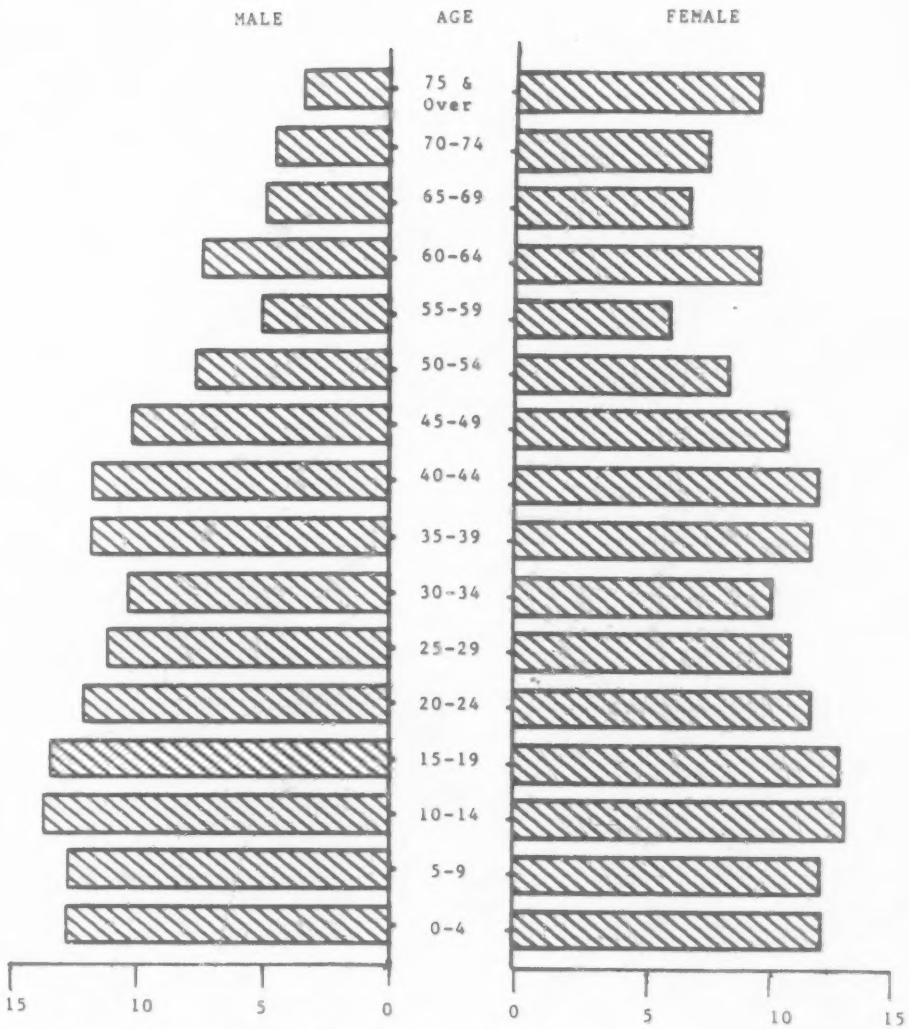
Figure 3. AGE - SEX PYRAMID 1985



Source: US Census Bureau Estimates and Projections.

Figure 4.

AGE - SEX PYRAMID 2000



Source: US Census Bureau Estimates and Projections.

Further examination of the projected age-sex composition for the year 2000 in figure 4 reveals a deficit of population at ages 55–59 in comparison to adjacent age groups, representing survivors of births during the second world war. The reduction in the number of women entering this age bracket in the late 1990's contributes to the upswing in growth of the working age population in table 1.

TABLE 1.—USSR TOTAL AND WORKING AGE POPULATIONS, MIDYEAR

[In thousands]

Date	All ages				Working ages			
	Population (thousands)	Increment (thousands)	Average increment (thousands)	Growth rate (percent)	Population (thousands)	Increment (thousands)	Average increment (thousands)	Growth rate (percent)
1950	180,526	16,124	3,225	17.10	103,345	11,313	2,263	20.76
1955	196,650	18,215	3,643	17.71	114,658	4,801	960	8.20
1960	214,865	16,649	3,330	14.92	119,459	4,683	937	7.69
1965	231,514	11,260	2,252	9.50	124,142	8,632	1,726	13.44
1970	242,774	11,983	2,397	9.63	132,774	11,261	2,252	16.27
1975	254,756	11,653	2,331	8.94	144,035	10,437	2,087	13.99
1980	266,410	12,448	2,490	9.13	154,472	2,823	565	3.62
1985	278,857	12,081	2,416	8.48	157,295	2,956	591	3.72
1990	290,939	10,245	2,049	6.92	160,251	3,802	760	4.69
1995	301,184	10,453	2,091	6.82	164,053	8,563	1,713	10.17
2000	311,637				172,616			

Note: The working ages consist of ages 16–59 for men and 16–54 women.

GEOGRAPHIC DISTRIBUTION

Republics

Major differences in the pace of population growth obtain among regions of the USSR. While growth has slowed to minimal rates in the European republics (excluding Moldavia) due to widespread adoption of small family size norms, Central Asian fertility levels imply completed family sizes of 4 or more children per couple. The regional fertility differentials are largely responsible for the trends in geographic distribution of the population in table 2. The Central Asian republics, which accounted for 11 percent of the USSR's population in 1959, have contributed more than a third of all population growth to 1985. According to the Census Bureau's current projections under the assumption of significant declines in Central Asian fertility, Central Asia will generate more than half of total population growth from 1985 to 2000. Nevertheless, the European republics will retain the overwhelming majority of the population, accounting for slightly less than 75 percent at the turn of the century. The proportion of the population residing in Central Asia is projected to reach roughly 21 percent in the year 2000.

TABLE 2.—POPULATION GROWTH, USSR AND REPUBLICS 1959 TO 2000

[In thousands]

Republic region	1959	1970	1979	1985	1990	1995	2000
USSR	208,827	241,720	264,129	278,857	290,939	301,184	311,637
Europe	176,345	196,625	209,189	216,975	221,927	224,938	227,799
RSFSR	117,534	130,079	138,193	143,861	147,210	149,110	150,931

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TABLE 2.—POPULATION GROWTH, USSR AND REPUBLICS 1959 TO 2000—Continued

[In thousands]

Republic region	1959	1970	1979	1985	1990	1995	2000
Ukraine	41,869	47,127	49,987	51,186	52,061	52,638	53,206
Byelorussia	8,056	9,002	9,609	10,028	10,379	10,622	10,831
Estonia	1,197	1,356	1,476	1,536	1,554	1,573	1,590
Lithuania	2,711	3,128	3,422	3,587	3,702	3,792	3,874
Latvia	2,093	2,364	2,536	2,609	2,633	2,650	2,667
Moldavia	2,885	3,569	3,966	4,169	4,386	4,552	4,700
Transcaucasus	9,505	12,295	14,198	15,387	16,668	17,791	18,870
Armenia	1,763	2,492	3,060	3,368	3,643	3,838	4,031
Azerbaydzhan	3,698	5,117	6,093	6,749	7,488	8,222	8,922
Georgia	4,044	4,686	5,045	5,270	5,537	5,731	5,917
Central Asia	22,977	32,800	40,743	46,496	52,344	58,455	64,968
Kazakh	9,295	13,009	14,820	16,124	17,444	18,727	20,036
Kirgiz	2,066	2,933	3,577	4,060	4,565	5,106	5,683
Tadzhik	1,981	2,900	3,872	4,620	5,413	6,270	7,206
Turkmen	1,516	2,159	2,810	3,282	3,776	4,305	4,877
Uzbek	8,119	11,799	15,663	18,410	21,146	24,046	27,166

Source: 1959, 1970—Soviet censuses (beginning of year); 1979 to 2000—unpublished republic projections prepared at CIR.

Urbanization

Urbanization ranks among the most fundamental components of economic and social development. By this standard the USSR lags behind the highly industrialized countries, having been predominantly rural until the early 1960's. Levels of urbanization vary substantially among regions of the USSR, with the Central Asian population remaining primarily rural to this day (see table 3). The difference in level of urbanization between the European and Central Asian republics has widened, even though the urban population has grown more rapidly in Central Asia than in the European republics, as a result of the differential in rural growth rates. Because the rural population of the European republics has been declining the proportion urban has grown more rapidly in these republics than the urban population itself, while the reverse has been the case in Central Asia.

TABLE 3.—LEVEL OF URBANIZATION: USSR AND REPUBLICS

Republic	Percent urban			
	1959	1970	1979	1986
USSR	47.88	56.26	62.33	65.62
Europe	49.21	58.81	66.05	70.29
RSFSR	52.42	62.26	69.34	73.06
Ukraine	45.73	54.51	61.32	66.07
Byelorussia	30.80	43.41	55.05	63.14
Estonia	56.47	64.97	69.71	71.60
Lithuania	38.58	50.22	60.68	66.31
Latvia	56.09	62.48	68.46	70.71
Moldavia	22.25	31.66	39.30	45.70
Transcaucasus	45.89	51.13	55.37	57.05
Armenia	50.03	59.47	65.75	67.85
Azerbaydzhan	47.78	50.11	53.09	53.92
Georgia	42.36	47.80	51.84	54.13
Central Asia	38.47	42.89	45.52	46.64
Kazakh	43.75	50.27	53.94	57.54
Kirgiz	33.69	37.40	38.71	39.67

TABLE 3.—LEVEL OF URBANIZATION: USSR AND REPUBLICS—Continued

Republic	Percent urban			
	1959	1970	1979	1986
Tadzhik	32.61	37.14	34.89	33.41
Turkmen	46.24	47.89	47.95	47.46
Uzbek	33.61	36.63	41.24	41.89

Source: Narkhoz 1985, pp. 8–9

NATIONALITY COMPOSITION

For many demographic issues the ethnic dimension is more meaningful than geographic location. The Central Asian population explosion represents a dilemma primarily because of the characteristics of the indigenous nationalities of Central Asia, whose utility as a source of industrial labor is handicapped by the rural background, low educational level, and limited proficiency in Russian of its members.[2] European nationalities contribute a disproportionate share of the industrial labor force in Central Asia. In this light it is significant that for the remainder of this century the growth of the able bodied population will be derived primarily from the Central Asian nationalities (see table 4). Over the current and the following five-year plans the European able-bodied population will continue to shrink as in the preceding period.

TABLE 4.—GROWTH OF THE WORKING AGE POPULATION BY NATIONALITY OVER 1981–85 TO 1996–2000 5-YEAR PLAN PERIODS

Period	Total USSR increment (thousands)	European naitonalities		Central Asian nationalities		Other nationalities	
		Increment (thousands)	Percent of total	Increment (thousands)	Percent of total	Others increment (thousands)	Percent of total
1981 to 1985	2,459	−802	−32.62	2,251	91.55	1,010	41.07
1986 to 1990	3,160	−68	−2.16	2,511	79.47	717	22.69
1991 to 1995	3,971	−95	−2.39	3,192	80.38	874	22.01
1996 to 2000	9,151	−3,044	33.27	4,412	48.21	1,695	18.52

Source: Projections of the population by major nationality described in Kingkade (forthcoming).

The ethnic composition of the draft age population is of special interest. According to Census Bureau estimates the number of draft age males has declined since 1970 among the major European nationalities while nearly doubling among Central Asians (see table 5). This has entailed a 10 percent drop in the European share of the draft age pool. Russians, who comprised the majority of the draft age population in 1970, had become a minority by 1985. The small size of the draft age pool in 1985 is another consequence of the second world war, in that children of mothers born during the war would reach the late teen ages on the average in the mid-1980's. Over the remainder of this century the draft age population

[2] DiMaio, A. J. "Contemporary Soviet Population Problems" in H. Desfosses (ed.) *Soviet Population Policy*, New York: Pergammon Press, 1981, p. 20; Feshbach, M. "The Soviet Union: Population Trends and Dilemmas," *Population Bulletin*, vol. 37, No. 3., p. 29; Crisostomo, R. *The Demographic Dilemma of the Soviet Union*, International Research Document No. 10, U.S. Bureau of the Census, 1983, p. 2.

will increase. The European and Russian factions will continue to decline as a result of the more rapid growth of the non-European component, particularly Central Asians. By the end of this century roughly one third of the draft age pool will be drawn from non-European nationalities and one fifth will be Central Asian.

TABLE 5.—ESTIMATED AND PROJECTED 17–18-YEAR-OLD MALES BY MAJOR NATIONALITY USSR 1979 TO 2000

Nationality	Population (in thousands)			Percent of total		
	1970	1985	2000	1970	1985	2000
Total	4,452	4,131	5,188	100.00	100.00	100.00
European	3,493	2,825	3,293	78.46	68.39	63.48
Slavic	3,305	2,651	3,094	74.23	64.18	59.64
Russian	2,488	1,929	2,291	55.89	46.70	44.16
Central Asian	364	654	1,125	8.18	15.82	21.68
Other	595	652	770	13.36	15.79	14.84

Source: See table 4.

MORTALITY

After a decade's lapse the USSR has resumed publication of the standard demographic measures which describe the mortality condition of the population. The official life expectancies at birth register a decline during the 1970's, particularly among males (see table 6). Soviet discussions explain this deterioration in terms of increases in mortality from accidents as well as chronic degenerative disease, often associated with alcoholism and smoking.[3] The greater proclivity to these lifestyle patterns of males as compared to females along with the male predominance in physically hazardous occupations is consistent with the sex differential in the mortality trend. Reductions in accident fatalities resulting from the anti-alcoholism campaign initiated in 1985 may be largely responsible for the rise in life expectancy in the final year of data but cannot account for the increase in the early 1980's. The latter may be due to improvements in child health care associated with the government's pronatalist fertility initiative, increased control of infectious disease, or episodic factors depressing the 1978–1979 life expectancy.

TABLE 6.—OFFICIAL LIFE EXPECTANCIES AT BIRTH, 1968–71 TO 1985–86

Date	Both sexes	Male	Female
1968 to 1971	70	65	74
1971 to 1972	70	64	74
1978 to 1979	68	62	73
1983 to 1984	68	63	73
1984 to 1985	68	63	73
1985 to 1986	69	64	73

Sources: Vestnik statistiki, 1974, No. 2, pp. 94–95. Narkhoz, 1985, p.

[3] Andreyev and Vishnevskiy, 1979, p. 28; Ryabushkin and Galetskaya, 1983, pp. 186–187; Polyakov et al., 1984, p. 18.

Age-specific data shed additional light on recent mortality trends (see table 7). During the 1970's death rates rose at all ages over 20 as well as in infancy, registering the greatest increases above age 45 where degenerative disease becomes pronounced. Between 1980–1981 and 1984–1985 the rates declined at all ages under 50—in most cases to levels below their values at the beginning of the 1970's. This implies significant reductions in mortality from accidents, which represent the leading cause of death among young adults.[4] The continued rise in old age mortality may reflect the longterm and frequently irreversible character of degenerative disease.

TABLE 7.—AGE-SPECIFIC DEATH RATES: USSR, 1969–85

[Per thousand]

Age	1969–70	1974–75	1980–81	1984–85
0 to 4	6.9	8.0	8.1	7.7
5 to 9	.7	.7	.7	.6
10 to 14	.6	.5	.5	.5
15 to 19	1.0	1.0	1.0	.9
20 to 24	1.6	1.7	1.8	1.5
25 to 29	2.2	2.1	2.3	2.0
30 to 34	2.8	3.0	3.0	2.8
35 to 39	3.7	3.7	4.4	3.6
40 to 44	4.7	5.2	5.6	5.7
45 to 49	6.0	6.7	8.0	7.3
50 to 54	8.7	8.7	10.8	11.3
55 to 59	11.7	12.8	13.9	15.1
60 to 64	18.0	18.3	20.6	20.4
65 to 69	27.5	27.9	29.5	31.1
70 +	75.7	75.2	77.2	78.7

Source: "Vestnik statistiki," No. 12, 1986, p. 71.

Mortality varies significantly among Soviet subpopulations. Table 8 presents estimates of life expectancy for five major nationalities which comprise roughly three quarters of the population. According to this sensitive indicator of the quantity and quality of life, the three Slavic nationalities fare better than average for the USSR, with Belorussians appreciably better off than Russians and Ukrainians. The difference between the life expectancies for Kirgiz, a Central Asian nationality, and Russians are comparable to the Black-White differential in the United States, although the U.S. levels are higher. The lower standard of living in rural as compared to urban areas, including differential accessibility and quality of health services,[5] may partly explain why the life expectancy

[4] Polyakov, I. V., N. S. Sokolova, Ye. A. Boyarinova, and N. G. Petrova, "Nekotoryye osobennosti smertnosti krupnogo goroda," *Zdravookhraneniye Rossiskoy Federatsii*, No. 4, 1984 (referred to hereafter as Polyakov et al., 1984), p. 18; Virganskaya, I. M., "K voprosu o predstoyashchey prodolzhitel'nosti zhizni v trudosposobnom vozraste," *Zdravookhraneniye Rossiskoy Federatsii*, No. 7, 1984, p. 27; Kopyt, N. Ya., "Mediko-sotsial'nyye faktory preodoleniya p'yanstva i alkogolizma," *Zdravookhraneniye Rossiskoy Federatsii*, No. 12, 1985 (referred to hereafter as Kopyt, 1985), p. 5; Ovcharov, V. K., "Osnovnyye napravleniya issledovaniy po sotsial'noy gigiyene i organizatsii zdravookhraneniye," *Sovetskoye zdravookhraneniye*, No. 4, 1985, p. 21.

[5] Gekht, I. A., "Nekotoryye mediko-sotsial'nyye problemy postareniya sel'skogo naseleniya," *Zdravookhraneniye Rossiskoy Federatsii*, No. 3, 1984, p. 18; Frolov, A. V., "Dosutochnaya letal'nost' detey pervogo goda zhizni sel'skoy mestnosti," *Zdravookhraneniye Rossiskoy Federatsii*, No. 8, 1985, pp. 27–30; Testemitsanu, N. A., "Aktual'nyye problemy sovershenstvovaniya organizatsii meditsinskoy pomoshchi sel'skogo naseleniya," *Zdravookhraneniye Tadzhikistana*, No. 6, 1984, p.

Continued

of the predominantly rural Moldavians is closer to the Kirgiz level than to those of the Slavic nationalities.

TABLE 8.—LIFE EXPECTANCIES AT BIRTH FOR SOVIET NATIONALITIES IN 1979

Nationality	Male	Female
USSR	62.45	72.77
Russians	62.96	73.12
Ukrainians	64.14	76.07
Belorussians	67.22	76.83
Moldavians	59.31	68.65
Kirgiz	56.47	66.12

Note: In deriving the life expectancies the offical infant mortality rates have been adjusted to conform to international statistical standards.
Source: Kingkade (forthcoming).

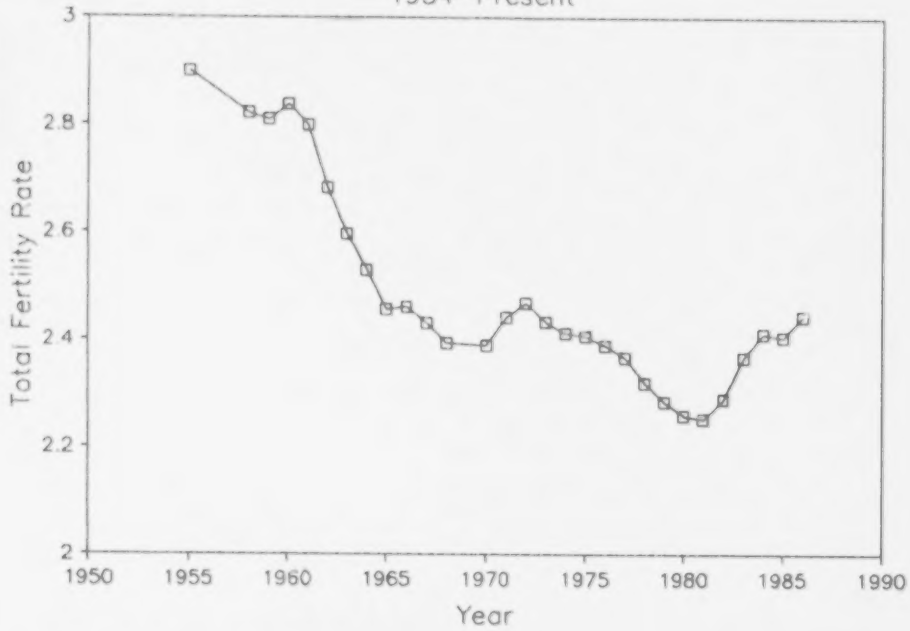
FERTILITY

Soviet fertility, which has fallen for most of the the postwar period, has risen significantly in the 1980's (see figure 5). As a result the level of Soviet fertility has regained the relatively high values of the mid-1960's and early 1970's. The recent increase occurred subsequently to the adoption by the 26th Party Congress of a set of maternity incentives centering on partially paid maternity leave for the period of one year for working women. After a slight downturn in 1985 fertility rose again substantially in 1986, perhaps partly reflecting the extension of paid maternity leave to 1.5 years by the 27th Party Congress.[6]

6; Grosheva, T. N., "Osobennosti rasprostranennosti serdechno-sosudistykh zabolevaniy sel'skogo naseleniya," *Zdravookhraneniye Rossiskoy Federatsii*, No. 12, 1984, p. 16.

[6] *Osnovnyye napravleiye eknomicheskogo i sotsial'nogo razvitiya SSSR na 1986-1990 gody i na period do 2000 goda*, Moscow: Politizdat, 1986 (hereafter referred to as *Osnovnyye*, 1986), p. 64.

Figure 5. Fertility Level of the USSR
1954–Present



Fertility levels vary sharply among regions of the USSR. Soviet analysts typically describe the European population of the USSR as having completed the "demographic transition" from natural to controlled reproduction, Central Asians as being in the initial phase, and Transcaucasians (usually together with Moldavians) as transitional. In general the European republics are characterized by fertility at the level of two children per couple, indicating widespread regulation of fertility (see table 9). At the same time Central Asian fertility is as high as that of many Third World countries with limited practice of family planning. The fertility levels of Transcaucasians together with Moldavians are intermediate between the Central Asian and the other European nationalities.

TABLE 9.—TOTAL FERTILITY RATES OF USSR AND UNION REPUBLICS

	1969–70	1979–80	1984–85
USSR	2.389	2.259	2.405
Urban	1,941	1.859	1.982
Rural	3.182	3.216	3.510
European Republics:			
RSFSR	1.971	1.887	2.058
Ukraine	2.044	1.960	2.055
Lithuania	2.354	2.011	2.096
Latvia	1.926	1.880	2.071
Estonia	2.143	2.011	2.110
Belorussia	2.298	2.037	2.078
Moldavia	2.563	2.382	2.676

TABLE 9.—TOTAL FERTILITY RATES OF USSR AND UNION REPUBLICS—Continued

	1969–70	1979–80	1984–85
Transcaucasus:			
Georgia	2.616	2.251	2.329
Azerbaydzhan	4.633	3.329	2.928
Armenia	3.195	2.383	2.488
Central Asia:			
Uzbek	5.636	4.905	4.653
Kirgiz	4.846	4.133	4.140
Tadzhik	5.903	5.760	5.492
Turkmen	5.930	5.133	4.666
Kazakh	3.307	2.939	3.034

Note: The total fertility rate represents the number of children a woman would bear if she spent her reproductive life under the fertility regime prevailing in the given years.

Source: Kingkade (forthcoming).

Systematic variations in fertility trends accompany the regional differences in fertility levels. The republic trends in the 1980's are consistent with the expected effect of the government's pronatalist policy. Fertility has risen primarily in the European republics where working women comprise the greatest shares of the female population in the reproductive ages.[7] The fertility levels of the European republics have converged close to the value that corresponds to zero population growth in the longrun.

Until the mid 1970's there was little evidence of fertility decline among the indigenous population of Central Asia. However, in 1976 a substantial decline in the level of reported fertility began in each of the three Central Asian republics whose titular nationalities predominate (Tadzhik, Turkmen, and Uzbek SSRs). Given that the Russian shares of the population have been declining in these republics [8] it is likely that the reported trends reflects actual declines in the fertility of Central Asian nationalities. Additional evidence is provided by Soviet presentations of nationally representative sample survey results, which reveal pronounced declines in family size expectations among women of Central Asian nationality born at successive dates in the postwar period.[9] Although to some extent these findings may reflect the fact that women born earlier had longer to experience unintended pregnancies, this in turn would indicate a reserve of unwanted fertility among native Central Asians liable to be reduced with increasing involvement of women in the labor force, expansion of education, and urbanization.

IV. Recent Population Policy Initiatives

MATERNITY INCENTIVES

The precipitous drop in fertility in the 1960's brought much of the population of the USSR below the fertility level required to replace existing labor resources by the latter half of the decade. In

[7] Heer, D., "Fertility and Female Work Statis in the USSR" in Helen Desfosses (ed.) *Soviet Population Policy*, New York: Pergammon Press, 1981 (hereafter referred to as Heer, 1981), p. 84.

[8] Kozlov, V.I., *National'nosti SSSR: Etnodemograficheskiy obzor* 2nd ed., Moscow: Finansy i statistika, 1982, pp. 117–122.

[9] Belova, passim; Bondarskaya, p. 29; Vishnevskiy and Volkov, 1983, pp. 235–241.

apparent response the Soviet government enacted certain legislation intended to stimulate fertility in the early 1970's. The more significant of these measures included extension of fully paid maternity leave for 56 days before and after birth to all working women regardless of length of employment and introduction of child support payments for low-income families.[10] These incentives had little effect on the trend in Soviet fertility. The shortlived upswing in the early 1970's, spurred perhaps by greater availability of housing, had come to a halt prior to the adoption of the measures. During the remainder of the decade fertility continued to decline.

Against the background of Brezhnev's appeal for an "effective demographic policy" at the 25th Party Congress Soviet demographers debated alternative strategies for influencing fertility.[11] A number of European demographers, noting that high fertility was occurring in areas far removed from the industrial centers where growth was needed, advocated a regionally differentiated approach that would stimulate the fertility of low fertility populations while lowering the fertility of high fertility populations in the direction of the 3-4 child family.[12] Others, including the Kazakh demographer Tatimov,[13] argued that any differential policy would be discriminatory. At the 26th Party Congress the former school of thought prevailed.

The "measures to strengthen governmental assistance to families with children" adopted by the 26th Party Congress[14] represented a major expansion of legal incentives to encourage fertility. A key element of this package is partially paid maternity leave for a year after birth for all women employed at their current jobs for at least one year along with the right to an additional half year of unpaid leave. Lump sum payments to working mothers of 50 rubles upon birth of the first child and 100 rubles for second and third births were added to the existing structure of payments producing a schedule which rewards fourth and fifth births at lower rates than third births. In addition, the measures call for the provision of housing in the form of individual rooms to recently married couples as well as housing improvement loans and priority for admission into housing cooperatives. The measures were scheduled to take effect in the "hardship posts" of the RSFSR (Far East, Siberia, Far North, Non Black Earth Zone) in 1981, other European areas in 1982, and the remainder of the USSR in 1983.[15] Although the phrasing of the governmental resolutions avoids any suggestion of differential treatment of European and non-European nationalities, the emphasis on working women in the legislation implies a signifi-

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[10] Ryabushkin and Galetskaya, 1983 pp. 204-209.

[11] Weber and Goodman, No. 2, 1981, pp. 279-295; Di Maio, 1981, pp. 16-43.

[12] Litvinova, G.I., "Vozdeystviye gosudarstva i prava na demograficheskiye protsessy," *Sovetskoye gosudarstvo i pravo*,, No. 1, 1978, p. 136; Urlanis, B. Ts., "Demograficheskaya nauka i demograficheskaya politika," *Vestnik Akademii Nauk SSSR*, No. 1, 1980, p. 46.

[13] Tatimov, M., *Razvitiye narodonaseleniya i demograficheskaya politika*, Alma-Ata: Nauka, 1978, p. 74.

[14] Postanovleniye, 1981a.

[15] Postanovleniye Soveta Ministrova SSSR i Vsesoyuznogo Tsentral'nogo Soveta Professional'nykh Soyuzov, "O poryadke vvedeniya chastichno oplachivayemogo optuska po ukhodu za rebenkom do dostizheniya im vozrasta odnogo goda i drugikh meropriyatiy po usileniyu gosudarstvenoy pomoshchi semyam imeyushcim detey," *Sobraniye postanovleniy pravitel'stva SSSR*, No. 24, 1981, p. 631.

cantly greater impact among Europeans, whose rates of female employment are substantially higher than those of non-Europeans.

The 27th Party Congress made few modifications of the existing fertility legislation. Partially paid maternity leave has been extended to 1.5 years while retaining the option of an additional half year's unpaid leave.[16] The Basic Guidelines for Economic and Social Progress for the 12th Five-Year Plan include provision of free pharmaceuticals for children under 3 years of age.[17]

Although the pronatalist measures introduced by the 26th Party Congress were probably instrumental in bringing about the rise in Soviet fertility in the 1980's, the prospects for further gains are less certain. The measures partially alleviate some of the most severe disadvantages of childbearing, such as loss of income and lack of dwelling space, restraining couples from having the number of children they desire. A permanent increase in family size norms among the urban European population will be more difficult to attain. The proportion of births comprised by third children has risen only slightly from 22 percent in 1980 to 25 percent in 1985.[18] East European experience with pronatalist policies suggests that the gains fertility due to material incentives tend to be short-lived.[19] A major improvement in living standards might produce a large-scale shift to bigger families, but this would be independent of the official maternity policy.

PUBLIC HEALTH

The Anti-Alcoholism Campaign

Soon after Gorbachev became General Secretary a major campaign against alcoholism was initiated. The Supreme Soviet and the Council of Ministers adopted resolutions discouraging drinking.[20] These measures limit the distribution and consumption of alcoholic beverages and impose penalities for public drinking and drunkenness. Penalities for production, distribution or sale of samogon are also included. State production of alcoholic beverages has been sharply cut and per capita consumption has declined significantly (see Treml in this volume).

While statements by Soviet officials about the success of the anti-alcoholism campaign should be interpreted cautiously, it is likely that the campaign has played a significant role in the reported decline in Soviet mortality in 1985–1986. Penalties for public drunkenness and drinking on the job would be apt to bring about a decline in accidents and therefore accident fatalities. The increase of one year in male life expectancy at birth reported for 1985–1986 is consistent with a reduction in accident fatalities, which exercise a stronger effect on male as compared to female life expectancy. The

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[16] *Osnovnyye*, 1986, p. 64.

[17] Ibid., p. 67.

[18] TSSU SSSR, *Narodnoye khozyaystvo SSSR v 1985 g.*, Moscow: Finansy i statistika, 1986 (hereafter referred to as *Narkhoz* 1985), p. 31.

[19] David, H.P., "Eastern Europe: Pronatalist Policies and Private Behavior," *Population Bulletin*, vol. 36, No. 6.

[20] Postanovleniye Soveta Ministrov SSSR, "O merakh po preodoloeniyu p'yanstva i alkogolizma, iskoreniyu samogonovareniya," *Sobranive Postanovleniy Pravitel'stva SSSR*, No. 17, 1985, pp. 306–312; Ukaz Preziduma Verkhovnogo Soveta SSR, "Ob usilenii bor' by a p'yanstvom," *Vedomosti Verkhovnogo Soveta SSSR*, No. 21, 1985, pp. 320–323.

one-year rise is roughly half of the potential gain in male life expectancy at birth that would result from elimination of traumas and poisonings according to data from a sample of large cities in 1982,[21] as well as an analysis of registered mortality in Belorussia during 1978–1979.[22] It is also probable that a reduction in alcohol consumption would tend to lessen mortality from various types of degenerative disease aggravated by alcoholism, including cardiovascular conditions as well as cirrhosis of the liver. A short term increase in poisonings among chronic alcoholics resorting to toxic substances for their intake may be occurring counterbalanced by the reduction in mortality from accidents.

The longer term impact on mortality of the anti-alcoholism campaign is difficult to predict after one year's experience from the limited information currently available. The decrease in accident mortality achieved thus far can be maintained given the existing conditions of enforcement. If findings that 70 percent or more of accident fatalities occur to inebriated individuals[23] are indicative, further declines in accident mortality can be obtained. Beyond this the potential for lowering mortality from degenerative disease is significant. Here, however, progress will depend on reductions in personal consumption of alcohol, which is more difficult to police than public inebriation. If the campaign has, as Yeltsin suggested, merely driven drinking indoors[24] its further effect on mortality will be limited.

Dispensarization

The term "dispensarization" refers to a specific approach to health care which consists of bringing various segments of the population under regular, repeated clinical observation.[25] Adopted earlier this century for certain elements of the urban population of the USSR including workers in hazardous occupations and persons diagnosed with contagious diseases such as tuberculosis, dispensarization represents a sound strategy for prevention and control of the degenerative diseases which are the leading causes of death at the present time. Given the nature of these diseases, whose symptoms tend to become acute only after the process has advanced too far to remedy, preventive monitoring becomes essential. Recognition of this fact may be a major reason for the appearance of large scale preventative examination of the population among the initiatives announced in recent Party resolutions on public health.[26] It is also evident that sections of the population, particularly in rural areas, suffer from a variety of preventable infectious diseases.[27]

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[21] Vitganskaya, 1984, p. 26

[22] Tal'chuk et al., 1982, p. 44.

[23] Kopyt, 1985, p. 5; Polyakov et al., 1984, p. 18.

[24] Reported in "*Le Monde* cities Yeltsin April Aktiv Address," FBIS Soviet Union Daily Report FBIS-SOV-86-146, July 30, 1986, p. R24.

[25] Novgorodtsev et al., 1984.

[26] Postanovleniye TsK KPSS i Soveta Ministrov SSSR, "O merakh po dal'neyshemu uluchsheniyu narodnogo zdravookhraneniya," *Spravochnik partynogo rabotnika*, vol 18, 1978, p. 225; Postanovleniye TsK KPSS i Soveta Ministrov SSSR, "O dopolnitel'nykh merakh po uluchsheniyu okhrany zdorov'ya naseleniya," *Sobraniye postanovleniy pravitel'stva SSSR*, No. 24, 1982, pp. 435–436.

[27] Aliyev, M.A., "O sostoyanii i merakh po dal'neyshemu uluchsheniyu zdravookhraneniya Kazakhstana," *Zdravookhraneniye Kazakhstana*, No. 8, 1985, p. 8; *Narkhoz*, 1985, p. 545.

The June 1983 Central Committee Plenum set forth the goal of annual dispensarization of the entire population [28] which is reiterated in the "Basic Guidelines for Economic and Social Development for the years 1986–1990 and the period to the year 2000." [29] This is obviously a long-term objective, as less than half of the population are covered by regular preventive examinations while roughly a quarter are under clinical dispensarization.[30] A recent book devoted to the subject regards dispensarization of all segments of the population as unlikely before the year 2005.[31]

During the late 1970's and early 1980's a series of large scale experiments were conducted in various oblasts of the RSFSR, Ukraine and Kazakhstan to test the feasibility of organizing dispensarization of the entire population.[32] This initiative is currently being expanded.

A computerized medical recordkeeping system modeled on (or otherwise analogous to) the Western systems which automate screening of patients and certain aspects of diagnosis is reported to have been introduced in Latvia.[33] According to the Latvian Minister of Health "In developing it we operated from the premise that to implement annual medical examination of the entire population solely by doctors would be beyond our power even with such a favorable supply of specialists as in the Latvian SSR." [34] The investment this system represents must be considerable.

What to expect from the dispensarization initiative is uncertain. It represents a clear recognition of the need to expand the coverage of health services. A significant expansion will undoubtedly require major new investments in medical facilities, supplies, and equipment. If these investments are made, major reductions in mortality are likely. Otherwise we have the latest "buzz word" in Soviet health services administration.

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[28] Novgorodtsev, G.A., G.Z. Demchenkova and M.L. Polonskiy, *Dispensarizatsiya naseleniya v. SSSR,* Moscow: Meditsina, 1984 (hereafter referred to as Novgorodtsev et al., 1984), p. 306.

[29] *Osnovnyye,* 1986, p. 66.

[30] *Narkhoz 1985,* p. 545–546.

[31] Novgorodtsev et.al., 1984, p. 306.

[32] Demchenkova, G.Z., M.L. Polonskiy and V.S. Preobrazhenskaya, "Dispanserizatsiya naseleniya i nauchno-technicheskaya revolyutsiya," *Zdravookhraneniye Rossiskoy Federatsi,* No. 8, 1985, pp. 8-9.

[33] Kaper,V.V. "Itogi i prespectiviy razvitiya zdravookhraneniya respubliki," *Sovetskoye zdravookhraneniye,* No. 3, 1986. pp. 5–6.

[34] Ibid, p. 6.

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LABOR FORCE AND EMPLOYMENT IN THE U.S.S.R.

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I. SUMMARY

This paper presents labor force and employment statistics for the U.S.S.R. and describes major trends. Labor force figures are estimated and projected from 1950 to the year 2000. The discussion includes sources of labor supply and changes in the composition of the labor force. Figures for annual average and work-hour employment cover the period 1950 to 1985. Factors affecting employment are described and annual average employment and work-hour employment are compared.

The able-bodied or working age population (officially defined as males 16 to 59 years of age and females 16 to 54 years of age) is the main source of the Soviet labor force, which is defined by Soviet censuses to include all individuals claiming an occupation as the

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principal source of income. In 1985, the working age population supplied 90 percent of the labor force. The maximum growth of this group, 22.9 million, occurred during the 1970's. The group will increase by only 6.1 million in the 1980's and by 11.6 million in the 1990's. The pension-age population, which is the main source of additional labor, is increasing rapidly (from 36.5 million in 1970 to 58.5 million in the year 2000) and by 2000, will provide 12 percent of the labor force, according to our projections.

The labor force itself will increase by 24 million in the last two decades of the century. Its growth exceeds the growth of the working age population by 6 million because of the increased participation of working age women in the labor force and the growing numbers of pensioners, more of whom continue to work. Our projections show the agricultural labor force decreasing from 24 percent of the civilian labor force in 1980 to 19 percent in the year 2000. The decrease is gradual and the share of labor in agriculture will remain high for an industrial country.

Annual average employment parallels the growth of the labor force. Between 1950 and 1985 both employment and the labor force increased approximately 75 percent, or 1.6 percent per year on average. The greatest growth in employment occurred in services, an annual average of 3.3 percent. During this period employment in agriculture decreased 18 percent, with a major shift among components. Employment fell in private agriculture by 14 percent and in collective farms by 54 percent, while it increased 256 percent in state agriculture. This shift resulted in part from the conversion of collective farms to state agriculture. Today, Soviet agricultural employment is divided in roughly equal shares among private agriculture, collective farms, and state agriculture. Industrial employment exceeded employment in services by 17 percent in 1950 but by 1985 had fallen 8 percent behind.

Work-hour employment increased 61 percent during the 35-year period compared to the 75 percent growth of the annual average employment. The slower growth in work hours is due to several factors. First, the work week in the state sector was reduced from 48 to 41 hours. Second, annual average employment in health and education increased at a higher rate than in the national economy, but approximately half of the employees in these branches work less than a 41-hour week. Third, the number of part-time workers increased in recent years.

II. Introduction

During most of the post-war period the Soviet Union has experienced a shortage of labor. The government has taken several steps to bring the maximum number of people into the labor market. Women have been granted longer maternity leave; pensioners have been given more incentives to work; and students have been provided more opportunities for part-time employment. This paper presents figures on the Soviet labor force and employment and discusses major trends for both categories.[1] Labor force is a broad con-

[1] More detailed data and methodology are presented in Stephen Rapawy and W. Ward Kingkade, "Estimates and Projections of the Labor Force and Civilian Employment in the U.S.S.R.: 1950 to 2000," U.S. Bureau of the Census, Center for International Research, forthcoming.

cept that counts individuals whereas employment is a measure of worktime, reported as an annual average or in work-hours. Annual average employment is derived from the number of days worked during the year per individual and work-hour employment indicates hours worked annually per person.

Section III on the labor force describes the sources of labor supply and presents estimates and projections of the labor force. The discussion includes a description of the growth and composition of the population and such ancillary sources of labor as pensioners, part-time workers, individuals working at home, and students. The labor force estimates and projections cover the period from 1950 to 2000. The civilian labor force estimates are distributed between the nonagricultural and agricultural sectors.

Section IV presents annual average employment and work-hour employment and discusses employment trends. Employment figures cover the period from 1950 to 1985 by branch of the economy and by branch of industry.

III. Labor Force

Soviet labor force data are obtained from the three population censuses taken during the post-war period, in 1959, 1970, and 1979. The census labor force figures include individuals who claim an occupation as their principal source of income, members of the armed forces, and pensioners working full-time. The figures exclude pensioners working part-time and full-time students, even if employed.

POPULATION

Figures on the total and the working age population, 1950–2000, are presented in the forthcoming paper.[2] The working age group provided 90 percent of the labor force in 1985. This group has been growing somewhat more slowly than the total population. The maximum growth occurred in the 1970's as the cohorts born in the 1950's reached working age. The rate of growth of the working age population will continue to decline until the late 1990's.

Table 1 presents the distribution of population in three groups: the working age group, those younger, and those older. The population is clearly aging. Because the retirement age in the Soviet Union is comparatively low (60 and males and 55 for females), this aging process removes a substantial portion of the population from full-time employment. Pensioners have become the primary source of supplementary labor resources. Other sources of labor include students, holders of more than one job, and individuals working part-time at home.

[2] Rapawy and Kingkade, forthcoming.

TABLE 1.—PERCENT DISTRIBUTION BY AGE OF THE POPULATION OF THE U.S.S.R: 1950 TO 2000

[Based on data as of July 1]

Year	Age group		
	0 to 15 years	16 to 59/54 years	60/55 years and over
1950	32.2	57.4	10.4
1960	31.8	55.8	12.4
1970	30.7	54.3	15.0
1980	26.5	58.0	15.5
1990	27.6	55.1	17.3
2000	25.8	55.4	18.8

Note: The middle age group includes the able-bodied ages, officially defined as males 16 to 59 years of age and females 16 to 54 years of age.
Source: Based on data in table 1 and sources cited, Rapawy and Kingkade, forthcoming.

The number of old-age pensioners increased from 846 thousand in 1950 to 39.3 million by the end of 1985.[3] The dramatic increase resulted from the aging of the population and change in pension laws. The most notable legal change was the extension of state pension coverage to collective farmers in 1965 [4] which added approximately 7 million old-age pensioners to the system.

Pensions have been increasing over time and currently the minimum pension in the state sector is 50 rubles per month. Maximum pension payments vary depending on wages received, type of work performed, and length of service. Since Janaury 1, 1980 individuals have been given inducements to continue working instead of retiring. In general, pension-age individuals who continue working in the state sector may choose to receive pension and wages or wages alone. If the second alternative is chosen, these older workers receive a bonus of 10 rubles per month for every year worked after reaching retirement age up to a maximum of 40 rubles. The combination of bonuses and pension usually cannot exceed 300 rubles per month.[5] Collective farm pensioners may also receive their full pensions as well as wages.[6]

The actual number of pensioners working full-time and part-time in the state sector, on collective farms, and on private plots is not available. Some data on pensioners can be derived based on participation rates reported in the 1970 and 1979 censuses but only for pension-age population working full-time in the state sector and on collective farms. The rates imply that 4.7 million worked in 1970 and 4.5 million in 1979.[7] Additional information is fragmentary and often combines pensioners working full-time and part-time. One source reports that the number of pensioners working in the state sector alone increased from 4.6 million in 1976 to 9.0 million

[3] Tsentral'noye statisticheskoye upravleniye (TsSU) SSSR, *Narodnoye khozyaystvo SSSR v 1985 godu; statisticheskiy yezhegodnik*, Moscow: Finansy i statistika, 1986, p. 451 (hereafter cited as *Narkhoz 85*) and "Statisticheskiye materialy," *Vestnik statistiki*, No. 8, August 1974, p. 95.

[4] Tsentral'noye statisticheskoye upravleniye (TsSU) pri Sovete Ministrov SSSR, *Narodnoye khozyaystvo SSSR v 1963 godu; statisticheskiy yezhegodnik*, Moscow: Statistika, 1964, p. 513.

[5] M.L. Zakharov, *Pensii rabochim i sluzhashchim*, Moscow: Profizdat, 1985, pp. 24–25, 202, and 215–216.

[6] A.G. Novitskiy and G.V. Mil', *Zanyatost' pensionerov; sotsial'no-demograficheskiy aspekt*, Moscow: Finansy i statistika, 1981, pp. 35 and 102.

[7] L. Chizhova, "Kak luchshe ispol'zovat' trud razlichnykh sotsial'no-demograficheskikh grupp naseleniya," *Sotsialisticheskiy trud*, No. 8, August 1984, p. 90.

in 1983.[8] Estimates based on the share of pensioners working in the state sector yield figures of 8.7 million and 10.7 million for 1982 and 1984, respectively.[9]

The number of pensioners working on collective farms is not available. The best information available is for the R.S.F.S.R. where in 1983, 32.8 percent of collective farm pensioners continued working (amounting to 1.1 million).[10] However, we do not believe that this proportion applies to the rest of the country. For comparision with full-time work equivalent figures (see below), we estimate that about 25 percent of all collective farm pensioners worked in 1979. This share is chosen as being somewhat lower than the 27.8 percent for state pensioners. In general, the pensioners on collective farms are older than in the state sector and are less likely to continue working. The 1979 share implies about 2.5 million collective farm pensioners.[11] A 1980 source indicates that 5 million old-age pensioners worked on private plots.[12]

Figures on employment for other groups supplying supplementary labor are even scarcer than those for pensioners. Students contribute labor in several ways: as part of their education when the work is performed in school shops or enterprises, in summer student brigades, in special brigades organized for a particular task, and as individuals working part-time. During the 1983/84 school year, 17 million students of working age (i.e. over 16) attended educational institutions full-time.[13] It is not possible to estimate the total number of students working, but data for 1983 indicate that 142,600 students at specialized secondary schools worked in student brigades, and 30.1 percent of full-time students worked during the summer in "third semester" brigades. The latter amounted in 118 thousand when converted to annual average employment.[14]

Dual job holders are employed largely in the service branches of the economy. In 1983, 1,384,200 were employed in the R.S.F.S.R. where they comprised 2.1 percent of the state sector employment. The share of dual job holders varies by region. The percentages were higher for the Baltic Republics (6.1 percent for Estonia) and decreased to less than 1.5 percent in Central Asian Republics.[15]

Individuals working part-time at home in 1983 comprised 0.6 percent of workers and employees, or 696,000. Women comprised 60 percent of these part-time workers. Managers evidently do not encourage this form of employment because they fear that many women working full-time would choose part-time work if available.[16]

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[8] T.V. Ryabushkin (Ed.), *Netrudospobnoye naseleniye: Sotsial'no-demograficheskiye aspekty*, Moscow: Nauka, 1985, p. 140.

[9] A.G. Novitskiy, "Dopolnitel'nyye reservy rabochey sily: Sotsial'noekonomicheskiye aspekty," in E.K. Vasil'yeva et al., *Trudovaya aktivnost' naseleniya*, Moscow: Mysel', 1986, p. 29 and *Narkhoz 85*, p. 451.

[10] Novitskiy, 1986, pp. 32–33 and Tsentral'noye statisticheskoye upravleniye (TsSU) RSFSR, *Narodnoye khozyaystvo RSFSR v 1984 godu; statisticheskiy yezhegodnik*, Moscow: Finansy i statistika, 1985, p. 276.

[11] Tsentral'noye statisticheskoye upravleniye (TsSU) pri Sovete Ministrov SSSR, *Narodnoye khozyaystvo SSSR v 1979 godu; statisticheskiy yezhegodnik*, Moscow: Statistika, 1980, p. 439.

[12] M. Ya. Sonin, *Razvitiye narodonaseleniya; ekonomicheskiy aspekt*, Moscow: Statistika, 1980, p. 60.

[13] V.V. Trubin, "Sovershenstvovaniye raspredeleniya rabochey sily kak metody povysheniya trudovoy aktivnosti naseleniya," in Vasil'yeva et al., 1986, p. 55.

[14] Novitskiy, 1986, pp. 40 and 42.

[15] *Ibid.*, p. 43.

[16] *Ibid.*, pp. 46 and 47.

We lack the information to determine the amount of labor supplied by each group, but scattered figures indicate their aggregate contribution is substantial. In 1983 more than 20 million persons from the "supplementary" labor sources worked in the R.S.F.S.R. When converted to annual average employment, the figure amounted to 9.9 million or 13.8 percent of employment in the R.S.F.S.R.'s socialized sector, increasing from less than 12 percent in 1980.[17] The most comprehensive figure for the U.S.S.R. on labor inputs from supplementary sources is an estimate by the Central Scientific Research Laboratory on Labor Resources for 1979.[18] The Laboratory estimated that over 11 million people (converted to full-year equivalent) worked during the year in the socialized sector and private plots. Pensioners comprised 84 percent; dual job holders, 9 percent; and women working at home and full-time students, 7 percent.

EDUCATIONAL SYSTEM

Education affects the quality and quantity of labor. The Soviet Government has been committed to raising the education level of the population with emphasis on polytechnical education. During the post-war period, would-be reformers have faced two conflicting demands, the need to meet the immediate labor requirements of a shortage-plagued economy and the long-term need for better trained labor to operate a modern economy. Reforms aimed at providing necessary general education, introducing production training into the curriculum, and making use of students free time for productive work.

The latest reform was outlined in decrees issued in 1984[19] and will affect education at all levels. Some changes have been introduced in September 1986 and the reform is scheduled to be completed by 1990.[20] The reform is designed to provide more polytechnical education, increase the share of students receiving vocational training, and enable more students to receive vocational training at enterprises and organizations.

It is difficult to assess the effects of the current reform on education and the labor force. It presumably will divert more students from wholly academic schools to schools that combine both academic and polytechnical training. However, emphasis on polytechnical education is likely to have a negative influence on academic training. At the time of rapid technological change, training students at an early age for specific occupations is likely to reduce their ability to adapt to technological change in the future. Students should contribute larger increments of labor to the economy, but the reform is not likely to bring young people into the labor market at an earlier age. Students of secondary and specialized secondary schools will graduate at the same age as before, 17 and 18 years, respectively. Curriculum in Secondary Specialized Schools have been lengthened by one-half year and students will graduate at 19 or 20

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[17] *Ibid.*, p. 47.

[18] Novitskiy and Mil', 1981, pp. 6–7.

[19] "Osnovnyye napravleniya reformy," *Uchitel'skaya qazeta*, April 17, 1984, pp. 2–3 and "Osnovnyye napravleniya reformy," *Uchitel'skaya gazeta*, January 5, 1984, pp. 2–3.

[20] "Postanovleniye Plenuma TsK KPSS, Ob Osnovnykh napravleniyakh reformy obshcheobrazovatel' noy i professional'noy shkoly," *Narodnoye obrazovaniye*, No. 6, June 1984, p. 7.

years of age. The length of studies in higher education evidently remains unchanged except that training of teachers has increased by 1 year.

At the same time, students in specialized secondary education and higher education may have their period of study reduced if they pursue a specialty similar to that at the lower level of education. Given these off-setting trends, the overall participation of young people in the labor market is likely to be minimal.

LABOR FORCE ESTIMATES AND PROJECTIONS

Labor force statistics are based on population censuses taken in 1959, 1970, and 1979. The statistics are based on questions which ask respondents to indicate their occupation, place of work, and source of income. The figures include individuals who claim to have an occupation regardless of whether they are working at the time of enumeration. This includes individuals who are on an authorized leave, have seasonal occupations, or are serving in the armed forces.[21] Pensioners employed full-time are counted in the labor force, but those working part-time are excluded.[22]

With each successive census fewer statistics and less explanatory material have been published. The 1959 census, for example, published a figure for the armed forces; the 1970 census simply indicated that the military is included in the labor force; and the 1979 census omitted any reference to the subject. A more serious shortcoming is the abridgement or omission of statistics on labor force by age and sex. These data are needed to estimate and project the labor force.

The 1959 census reported participation rates by age and sex for the socialized sector, together with less detailed information for age and sex structure of the population engaged in private agriculture. The 1970 census published participation rates for the socialized sector disaggregated by age but not by sex. This omission was rectified later when labor force figures were published for the socialized sector and for private agriculture by age and sex.[23] No participation rates were published in the 1979 census results. However, rates for the socialized sector were published in an article; the figures aggregated broad age groups and combined both sexes.[24] The rates indicate that an increased participation of the working age population since 1970 is confined to women. Rates for pension-age population working fulltime declined. The rates for 1979 were disaggregated and adjusted to make them methodologically consistent with the rates of the previous two censuses.[25]

Table 2 presents estimates and projections of the Soviet labor force from 1950 to 2000. During this period, the labor force is projected to increase by 74 million. The bulk of this increase has already occurred. Less than 20 million will be added to the labor

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[21] Tsentral'noye statisticheskoye upravleniye (TsSU) pri Sovete Ministrov SSSR, *Vsesoyuznaya perepis' naseleniya—vsenarodnoye delo,* Moscow: Statistika, 1978, pp. 54–55.

[22] Tsentral'noye statisticheskoye upravleniye (TsSU) pri Sovete Ministrov SSSR, *Itogi Vsesoyuznoy perepisi naseleniya 1970 goda, Tom IV,* Moscow: Statistika, 1973, pp. 4–6.

[23] "Statisticheskiye materialy," *Vestnik statistiki,* No. 12, December 1974, p. 90.

[24] Chizhova, 1984, p. 90.

[25] Adjustment and projections of the 1979 rates are described in Rapawy and Kingkade, forthcoming.

force between 1986 and the end of the century. Females accounted for more than half the working age population in the past because of the war and purges that decimated the male population more than the female population. However, as the sex structure of the population assumes more normal distribution the share of males increases until parity is reached in the mid-1980's. Thereafter the share of sales increases. The civilian labor force is projected to increase by about the same absolute amount as the total labor force. A considerable structural shift occurs within the civilian labor force as the share of labor engaged in agriculture decreases from 54 percent in 1950 to 19 percent in the year 2000. However, most of the shift occurred during the 1950's and 1960's. In recent years, the rate of decrease has slowed considerably.

TABLE 2.—ESTIMATES AND PROJECTIONS OF THE LABOR FORCE IN THE U.S.S.R.: 1950 TO 2000

[In thousands as of July 1]

Year	Total labor force				Civilian labor force		
	Total	Males	Females	Armed Forces	Total	Non-agricultural	Agricultural
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
VARIANT: MEDIUM							
1950	97,641	(*NA*)	(*NA*)	4,600	93,041	42,796	50,245
1951	97,952	(*NA*)	(*NA*)	5,100	92,852	44,494	48,358
1952	98,669	(*NA*)	(*NA*)	5,600	93,069	45,912	47,157
1953	100,415	(*NA*)	(*NA*)	6,100	94,315	47,025	47,290
1954	103,893	(*NA*)	(*NA*)	5,950	97,943	48,731	48,731
1955	104,973	(*NA*)	(*NA*)	5,800	99,137	49,753	49,384
1956	106,706	(*NA*)	(*NA*)	4,600	102,106	51,404	50,702
1957	106,694	(*NA*)	(*NA*)	3,900	102,794	53,267	49,527
1958	108,964	(*NA*)	(*NA*)	3,800	105,164	55,382	49,782
1959	109,264	52,722	56,542	3,900	105,364	57,780	47,584
1960	110,132	53,215	56,917	3,973	106,159	60,723	45,436
1961	111,211	53,776	57,435	3,325	107,886	63,839	44,047
1962	112,389	54,348	58,041	3,925	108,464	65,768	42,696
1963	113,630	54,951	58,679	3,600	110,030	67,704	42,326
1964	114,989	55,646	59,343	3,570	111,419	70,080	41,339
1965	116,494	56,420	60,074	3,380	113,114	73,077	40,037
1966	118,138	57,266	60,872	3,395	114,743	75,491	39,252
1967	119,893	58,184	61,709	3,470	116,423	77,827	38,596
1968	121,716	59,179	62,537	3,470	118,246	80,355	37,891
1969	123,584	60,218	63,366	3,550	120,034	82,725	37,309
1970	125,566	61,249	64,317	3,535	122,031	85,065	36,966
1971	127,773	62,425	65,349	3,675	124,098	87,442	36,656
1972	129,985	63,598	66,386	3,675	126,310	89,919	36,390
1973	132,201	64,770	67,430	3,725	128,476	91,834	36,642
1974	134,421	65,940	68,480	3,835	130,586	93,907	36,679
1975	136,646	67,109	69,537	4,005	132,641	96,556	36,084
1976	138,875	68,276	70,599	4,000	134,875	99,063	35,812
1977	141,108	69,441	71,668	4,125	136,983	101,469	35,514
1978	143,347	70,604	72,743	4,088	139,259	103,817	35,442
1979	145,547	71,740	73,807	4,118	141,429	106,478	34,951
1980	147,335	72,856	74,479	4,118	143,217	108,497	34,720
1981	148,919	73,869	75,050	4,233	144,686	110,208	34,479
1982	150,257	74,761	75,496	4,265	145,992	111,327	34,665
1983	151,406	75,546	75,860	4,265	147,141	112,395	34,746
1984	152,417	76,232	76,185	4,265	148,152	113,334	34,819
1985	153,306	76,838	76,468	4,265	149,041	114,516	34,525
1986	154,087	77,375	76,712	4,265	149,822	115,737	34,085
1987	154,843	77,867	76,976	4,265	150,578	116,662	33,916
1988	155,652	78,347	77,305	4,265	151,387	117,639	33,748

TABLE 2.—ESTIMATES AND PROJECTIONS OF THE LABOR FORCE IN THE U.S.S.R.: 1950 TO 2000—Continued

[In thousands as of July 1]

Year	Total labor force				Civilian labor force		
	Total	Males	Females	Armed Forces	Total	Non-agricultural	Agricultural
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1989	156,540	78,863	77,677	4,265	152,275	118,694	33,581
1990	157,498	79,435	78,064	4,265	153,233	119,819	33,414
1991	158,528	80,071	78,457	4,265	154,263	121,015	33,249
1992	159,622	80,782	78,840	4,265	155,357	122,273	33,084
1993	160,816	81,570	79,245	4,265	156,551	123,630	32,920
1994	162,104	82,393	79,711	4,265	157,839	125,082	32,757
1995	163,466	83,234	80,232	4,265	159,201	126,606	32,595
1996	164,857	84,073	80,784	4,295	160,592	128,158	32,434
1997	166,324	84,903	81,421	4,265	162,059	129,786	32,273
1998	167,959	85,759	82,199	4,265	163,694	131,581	32,113
1999	169,785	86,714	83,071	4,265	165,520	133,566	31,954
2000	171,702	87,751	83,951	4,265	167,437	135,641	31,796

NA—Not available.

Source: Repawy and Kingkade, forthcoming.

IV. Employment

Employment statistics are presented here in two forms, annual average and work-hour employment. Annual average employment is a measure of worktime based on days worked. Work-hour employment indicates the number of hours worked in the national economy. This section will present annual average employment and work-hour employment for all branches of the economy and for selected branches of industry from 1950 to 1985.

ANNUAL AVERAGE EMPLOYMENT

Soviet methodology for determining annual average employment has already been described and does not require further discussion.[26] Figures on annual average employment have been published in official Soviet statistics by branch of the national economy with varying degree of completeness since 1950. Employment for selected branches of industry was published until 1975, but the data were incomplete. The figures presented here include the official data and estimates that fill the gaps.

Table 3 presents annual average employment by branch of the national economy in the state sector. Statistics are aggregated by type of activity regardless of administrative subordination but include some employment in subsidiary activities. Agriculture includes considerable amounts of employment in auxiliary activities; in 1985, 1.1 million were engaged in nonagricultural activities. During the 35-year period, data reported by branch have been modified by changes in classification. Extensive adjustments were required to derive a reasonably consistent set of figures.

[26] Rapawy and Kingkade (forthcoming) and Murray Feshbach, "Soviet Industrial and Productivity Statistics" in Vladimir G. Treml and John P. Hardt (Eds.), *Soviet Economic Statistics*, Durham, N.C.: Duke University Press, 1972, pp. 197–201.

TABLE 3.—ANNUAL AVERAGE EMPLOYMENT IN THE STATE SECTOR IN THE U.S.S.R. BY BRANCH OF THE ECONOMY: 1950 TO 1985

[In thousands]

Year	Total	Agriculture	Nonagricultural Branches														
			Total	Industry	Construction	Forestry	Transport	Communications	Trade, public dining, materials technical supply, and procurement	Housing—communal economy and personal services	Health services	Education and culture	Art	Science and scientific services	Credit and insurance organizations	Government administration	Other
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
1950	40,420	3,437	36,983	15,317	3,278	444	4,117	542	3,360	1,371	2,051	3,315	185	714	264	1,831	194
1951	42,300	3,574	38,726	16,230	3,414	453	4,370	554	3,444	1,428	2,139	3,434	194	763	263	1,809	231
1952	43,900	3,711	40,189	16,873	3,578	462	4,623	565	3,528	1,485	2,226	3,553	202	811	262	1,786	235
1953	45,400	4,056	41,344	17,617	3,685	416	4,794	582	3,496	1,519	2,308	3,647	211	830	263	1,726	250
1954	49,100	6,026	43,074	18,499	4,064	402	4,925	596	3,626	1,551	2,468	3,817	219	866	264	1,544	233
1955	50,251	6,117	44,134	18,984	4,119	389	5,056	611	3,756	1,583	2,627	3,988	228	916	265	1,361	251
1956	51,869	6,043	45,826	19,702	4,523	390	5,232	624	3,826	1,666	2,736	4,103	245	1,005	266	1,342	166
1957	54,460	6,744	47,716	20,357	5,014	377	5,368	641	4,017	1,721	2,892	4,250	263	1,092	261	1,294	169
1958	56,005	6,125	49,880	20,997	5,495	367	5,681	664	4,190	1,754	3,059	4,378	280	1,218	260	1,294	243
1959	57,867	5,693	52,174	21,670	5,921	352	5,984	691	4,389	1,815	3,245	4,556	298	1,349	260	1,273	371
1960	62,032	6,964	55,068	22,620	6,319	359	6,279	738	4,675	1,920	3,461	4,803	315	1,592	265	1,245	477
1961	65,861	7,686	58,175	23,817	6,541	378	6,518	790	5,010	2,030	3,677	5,165	346	1,821	277	1,295	510
1962	68,300	8,016	60,284	24,677	6,523	389	6,677	832	5,253	2,096	3,818	5,521	340	2,014	283	1,316	545
1963	70,526	8,157	62,369	25,442	6,684	399	6,841	877	5,487	2,182	3,933	5,835	353	2,167	289	1,308	572
1964	73,258	8,377	64,881	26,317	6,883	404	7,054	928	5,752	2,282	4,082	6,204	362	2,288	296	1,354	675
1965	76,915	8,928	67,987	27,447	7,301	402	7,252	1,007	6,009	2,386	4,277	6,600	370	2,401	300	1,460	775
1966	79,709	9,123	70,586	28,514	7,549	409	7,364	1,073	6,261	2,489	4,427	6,902	380	2,512	313	1,539	854
1967	82,274	9,064	73,210	29,448	7,880	412	7,467	1,123	6,575	2,674	4,545	7,188	387	2,622	329	1,635	925
1968	85,100	9,129	75,971	30,428	8,149	421	7,606	1,187	6,964	2,800	4,747	7,532	393	2,760	346	1,711	927
1969	87,922	9,318	78,604	31,159	8,572	426	7,803	1,269	7,287	2,930	4,927	7,812	403	2,893	363	1,799	961
1970	90,186	9,419	80,767	31,593	9,052	433	7,985	1,330	7,537	3,052	5,080	8,070	412	2,999	388	1,838	998
1971	92,799	9,744	83,055	32,030	9,549	432	8,203	1,394	7,816	3,213	5,239	8,308	420	3,129	411	1,889	1,022
1972	95,242	9,894	85,348	32,461	9,986	443	8,446	1,435	8,100	3,376	5,386	8,530	428	3,297	439	1,960	1,061
1973	97,466	10,136	87,330	32,875	10,091	444	8,705	1,465	8,392	3,527	5,522	8,759	434	3,484	465	2,036	1,131
1974	99,780	10,357	89,423	33,433	10,339	449	8,922	1,499	8,640	3,664	5,655	8,977	441	3,609	493	2,115	1,187
1975	102,160	10,521	91,639	34,054	10,574	453	9,215	1,528	8,857	3,805	5,769	9,191	446	3,790	519	2,188	1,250
1976	104,235	10,767	93,468	34,815	10,716	449	9,378	1,555	9,010	3,896	5,878	9,392	448	3,860	546	2,235	1,290

1977	106,393	10,999	95,394	35,417	10,880	452	9,609	1,575	9,204	4,046	5,962	9,622	449	3,969	574	2,290	1,345
1978	108,616	11,258	97,358	36,014	11,034	458	9,863	1,599	9,361	4,218	6,033	9,915	451	4,069	604	2,348	1,391
1979	110,592	11,381	99,211	36,496	11,156	458	10,110	1,613	9,526	4,354	6,197	10,128	456	4,264	632	2,411	1,410
1980	112,498	11,650	100,848	36,891	11,240	458	10,324	1,634	9,694	4,512	6,223	10,456	457	4,379	649	2,495	1,436
1981	113,961	11,814	102,147	37,236	11,298	459	10,523	1,649	9,828	4,575	6,330	10,640	462	4,477	662	2,556	1,452
1982	115,163	12,019	103,144	37,610	11,299	459	10,671	1,666	9,863	4,612	6,448	10,816	463	4,475	676	2,591	1,495
1983	116,052	12,165	103,887	37,830	11,315	459	10,764	1,674	9,889	4,695	6,568	10,919	460	4,471	681	2,626	1,536
1984	116,829	12,206	104,623	37,957	11,349	457	10,815	1,672	9,954	4,785	6,672	11,065	458	4,508	684	2,658	1,589
1985	117,798	12,240	105,558	38,103	11,492	456	10,878	1,671	10,031	4,894	6,784	11,273	458	4,554	679	2,663	1,622

Source: Rapawy and Kingkade, forthcoming

Employment in the state sector increased 191 percent in 35 years and more than doubled for most branches. Employment in forestry remained essentially unchanged, and employment in government rose by a suprisingly moderate 45 percent. Employment in state agriculture increased 256 percent, partially as a result of the conversion of collective farms to state farms and the increased share of nonagricultural work. The largest growth occurred in the "Other" branch where employment in 1985 was eight times employment in 1950. This branch contains a miscellany of activities such as editorial and publishing, motion pictures, and procurement of scrap metal and waste. In addition, the branch evidently contains some police, including administrative personnel of prisons,[27] and administrative personnel of units financed by their subordinate organizations.

Table 4 presents employment by branch of industry. The branch of industry employment statistics have been subject to reclassification and over the years, the published data are not comprehensive.[28] Reported data for the earlier years frequently were limited to wage workers (blue collar workers). Because branch of industry employment data have not been published since 1975 employment for the last 10 years has been estimated based on output and productivity rates. However, the results of this procedure had to be adjusted because the estimates consistently summed to less than the reported totals for industry. Accordingly, the difference was distributed among the branches proportionally. The adjustment varied from a minimum of 0.6 percent in 1976 to a maximum of 2.4 percent in 1982.

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[27] Stephen Rapawy, *Comparison of U.S. and U.S.S.R. Civilian Employment in Government: 1950–1969*, International Population Reports, Series p–95, No. 69, Washington, D.C.: U.S. Department of Commerce, Bureau of Economic Analysis, Social and Economic Statistics Administration, April 1972, pp. 21 and 23–24.

[28] The latest available official classification lists 16 branches of industry. Data are presented here for 11 branches of industry, 10 of which nominally correspond to the official list. Other industry here includes: glass .and procelain-faience; micro-biological industry; feed processing; medical industry; and printing. Employment in food industry in this paper includes flour milling and cereal preparation, which are officially classified as a separate branch together with feed processing. (Tsentral'noye statisticheskoye upravleniye (TsSU) pri Sovete Ministrov SSSR, *Obshchesoyuznyy klassifikator otrasli narodnogo khozyaystva; 1 75 018; izdaniye ofitsial'noye*, Moscow: Statistika, 1976, pp. 145–46 and "Statisticheskiye materialy," *Vestnik statistiki*, No. 11, November 1972, p. 93.)

TABLE 4.—ANNUAL AVERAGE EMPLOYMENT IN SELECTED BRANCHES OF INDUSTRY IN THE U.S.S.R.: 1950 TO 1985

[In thousands]

Year	Total industry	Electric power	Fuels					Chemical and petrochemical		Ferrous metallurgy	Nonferrous metallurgy	Machine-building and metal working	Construction material	Timber, woodworking, and pulp and paper		Light industry	Food industry	Other industry
			Total	Coal	Oil extraction	Oil refining	Gas	Total	Chemical					Total	Pulp and paper			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
1950	15,317	184	1,243	859	68	44	9	469	371	743	317	4,307	699	2,208	140	2,653	1,683	811
1951	16,230	197	1,286	875	70	50	9	494	395	780	332	4,535	757	2,268	144	2,780	1,725	1,076
1952	16,873	211	1,329	891	76	54	9	521	418	817	348	4,775	819	2,329	148	2,913	1,768	1,043
1953	17,617	226	1,372	926	81	59	9	549	443	850	362	5,028	887	2,392	152	3,053	1,812	1,086
1954	18,499	242	1,415	986	77	66	8	579	467	871	371	5,294	960	2,457	156	3,200	1,857	1,253
1955	18,984	260	1,457	1,047	82	73	9	610	490	891	380	5,565	1,039	2,524	161	3,348	1,903	1,007
1956	19,702	283	1,523	1,129	83	80	10	643	503	916	390	5,860	1,129	2,557	163	3,445	1,952	1,004
1957	20,357	308	1,590	1,194	83	85	13	678	517	941	401	5,171	1,227	2,590	165	3,545	2,003	903
1958	20,997	335	1,656	1,256	86	88	18	715	530	966	412	6,498	1,334	2,624	167	3,648	2,055	754
1959	21,670	364	1,628	1,245	85	91	18	754	567	996	424	6,842	1,450	2,658	169	3,754	2,108	692
1960	22,620	397	1,568	1,196	85	95	18	792	603	1,047	446	7,206	1,575	2,698	173	3,860	2,164	867
1961	23,817	422	1,545	1,171	87	99	18	868	658	1,090	477	7,682	1,602	2,722	180	3,957	2,259	1,193
1962	24,677	449	1,522	1,162	88	103	19	951	730	1,122	509	8,189	1,629	2,746	187	4,030	2,326	1,204
1963	25,422	477	1,541	1,158	88	107	20	1,042	825	1,161	540	8,729	1,657	2,771	195	4,034	2,370	1,120
1964	26,317	507	1,560	1,166	92	112	23	1,142	900	1,200	572	9,305	1,685	2,796	203	4,171	2,481	898
1965	27,447	540	1,579	1,200	94	116	25	1,251	972	1,236	603	9,905	1,716	2,819	212	4,308	2,592	898
1966	28,514	581	1,588	1,202	99	116	27	1,346	1,033	1,267	615	10,400	1,774	2,827	235	4,471	2,680	965
1967	29,448	602	1,595	1,204	102	116	28	1,424	1,093	1,298	627	10,846	1,831	2,830	245	4,651	2,786	958
1968	30,428	625	1,606	1,194	101	116	28	1,468	1,127	1,333	639	11,282	1,901	2,858	252	4,800	2,893	1,023
1969	31,159	635	1,574	1,168	101	117	28	1,523	1,169	1,348	651	11,698	1,955	2,833	255	4,914	2,911	1,117
1970	31,593	633	1,542	1,120	102	117	29	1,568	1,203	1,359	663	12,017	1,996	2,848	259	5,019	2,901	1,047
1971	32,030	645	1,513	1,090	102	117	30	1,598	1,239	1,352	660	12,369	2,039	2,829	260	5,036	2,903	1,086
1972	32,461	655	1,479	1,056	103	117	31	1,626	1,251	1,354	660	12,718	2,070	2,821	262	5,034	2,920	1,124
1973	32,875	659	1,447	1,025	104	118	32	1,667	1,275	1,356	662	13,049	2,093	2,807	264	5,045	2,936	1,154
1974	33,433	671	1,425	1,002	104	119	34	1,706	1,229	1,366	666	13,424	2,115	2,799	267	5,074	2,986	1,201
1975	34,054	686	1,434	1,009	104	120	36	1,753	1,335	1,369	670	13,816	2,151	2,795	269	5,109	3,015	1,256
1976	34,815	703	1,456	1,015	106	122	37	1,797	1,368	1,390	680	14,287	2,185	2,784	276	5,189	3,033	1,311
1977	35,417	722	1,470	1,029	107	123	37	1,810	1,394	1,403	687	14,628	2,226	2,785	276	5,236	3,093	1,357
1978	36,014	740	1,508	1,062	109	124	39	1,870	1,433	1,414	692	14,928	2,243	2,808	280	5,275	3,117	1,419
1979	36,496	759	1,551	1,092	110	124	40	1,885	1,457	1,415	693	15,218	2,266	2,810	283	5,278	3,148	1,473

TABLE 4.—ANNUAL AVERAGE EMPLOYMENT IN SELECTED BRANCHES OF INDUSTRY IN THE U.S.S.R.: 1950 TO 1985—Continued

[In thousands]

Year	Total industry	Electric power	Fuels					Chemical and petrochemical		Ferrous metallurgy	Nonferrous metallurgy	Machine-building and metal-working	Construc-tion material	Timber, woodworking, and pulp and paper		Light industry	Food industry	Other industry
			Total	Coal	Oil extraction	Oil refining	Gas	Total	Chemical					Total	Pulp and paper			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
1980	36,891	785	1,570	1,106	111	125	41	1,917	1,478	1,421	696	15,437	2,275	2,797	292	5,297	3,161	1,535
1981	37,236	799	1,594	1,120	115	126	42	1,941	1,478	1,426	698	15,574	2,283	2,811	293	5,338	3,179	1,593
1982	37,610	823	1,633	1,150	118	127	42	1,958	1,500	1,453	711	15,735	2,321	2,807	297	5,326	3,185	1,658
1983	37,830	837	1,648	1,170	120	126	43	1,967	1,510	1,456	713	15,833	2,346	2,819	298	5,308	3,187	1,716
1984	37,957	853	1,654	1,168	123	126	43	1,968	1,521	1,451	710	15,948	2,347	2,797	298	5,260	3,192	1,777
1985	38,103	872	1,669	1,164	126	126	44	1,981	1,515	1,462	716	16,047	2,342	2,804	297	5,202	3,174	1,834

Source: Rapawy and Kingkade, forthcoming.

Total industry employment increased 149 percent between 1950 and 1985. Employment in electric power in 1985 was 4.7 times employment in 1950, the highest rate of growth among any branch. In machine-building and metalworking, the dominant industrial branch, employment in 1985 was 3.7 times employment in 1950, or 42 percent of total industrial employment.

Table 5 presents total annual average employment in the Soviet Union. Most of the data were presented in earlier tables. The additional data in this table include employment on collective farms, in private agriculture, and for independent artisans.

TABLE 5.—ANNUAL AVERAGE EMPLOYMENT IN THE NATIONAL ECONOMY OF THE U.S.S.R.: 1950 TO 1985

[In thousands]

Year	Total	Nonagricultural sectors						Agricultural sectors				Socialized sector			Private sector		
		Total	Industry	Other nonagricultural			Independent artisans	Total	State	Collective farm	Private	Total	Workers and employees	Collective farm	Total	Independent artisans	Private agriculture
				Total	Services [1]	Other [2]											
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
1950	80,646	37,611	15,317	21,666	13,091	8,575	628	43,035	3,437	27,600	11,998	68,020	40,420	27,600	12,626	628	11,998
1951	80,421	39,300	16,230	22,496	13,474	9,022	574	41,121	3,574	26,933	10,614	69,233	42,300	26,933	11,188	574	10,614
1952	80,746	40,709	16,873	23,316	13,853	9,463	520	40,037	3,711	26,267	10,059	70,167	43,900	26,267	10,579	520	10,059
1953	82,337	41,810	17,617	23,727	14,000	9,727	466	40,527	4,056	25,600	10,871	71,100	45,400	25,600	11,337	466	10,871
1954	86,194	43,486	18,499	24,575	14,355	10,220	412	42,708	6,026	25,200	11,482	74,300	49,100	25,200	11,894	412	11,482
1955	87,642	44,492	18,984	25,150	14,724	10,426	358	43,150	6,117	24,800	12,233	75,051	50,251	24,800	12,591	358	12,233
1956	90,383	46,130	19,702	26,124	15,189	10,935	304	44,253	6,043	25,700	12,510	77,569	51,869	25,700	12,814	304	12,510
1957	91,496	47,966	20,357	27,359	15,790	11,569	250	43,530	6,744	24,300	12,486	78,760	54,460	24,300	12,736	250	12,486
1958	93,702	50,077	20,997	28,883	16,433	12,450	197	43,625	6,125	24,900	12,600	80,905	56,005	24,900	12,797	197	12,600
1959	94,047	52,355	21,670	30,504	17,185	13,319	181	41,692	5,693	24,500	11,499	82,367	57,867	24,500	11,680	181	11,499
1960	95,398	55,233	22,620	32,443	18,276	14,172	165	40,165	6,964	22,300	10,901	84,332	62,032	22,300	11,066	165	10,901
1961	97,968	58,324	23,817	34,356	19,621	14,737	149	39,644	7,686	20,700	11,258	86,561	65,861	20,700	11,407	149	11,258
1962	99,727	60,417	24,677	35,607	20,641	14,966	133	39,310	8,016	20,000	11,294	88,300	68,300	20,000	11,427	133	11,294
1963	100,905	62,486	25,442	36,927	21,554	15,373	117	38,419	8,157	19,400	10,862	89,926	70,526	19,400	10,979	117	10,862
1964	103,465	64,982	26,317	38,564	22,620	15,944	101	38,483	8,577	19,200	10,906	92,458	73,258	19,200	11,007	101	10,906
1965	107,929	68,072	27,447	40,540	23,803	16,737	85	39,857	8,928	18,900	12,029	95,815	76,915	18,900	12,114	85	12,029
1966	110,669	70,655	28,514	42,072	24,823	17,249	69	40,014	9,123	18,600	12,291	98,309	79,709	18,600	12,360	69	12,291
1967	112,636	73,263	29,448	43,762	25,955	17,807	53	39,373	9,064	18,400	11,909	100,674	82,274	18,400	11,962	53	11,909
1968	114,853	76,008	30,428	45,543	27,253	18,290	37	38,845	9,129	18,100	11,616	103,200	85,100	18,100	11,653	37	11,616
1969	116,600	78,626	31,159	47,445	28,414	19,031	22	37,974	9,318	17,500	11,156	105,422	87,922	17,500	11,178	22	11,156
1970	118,565	80,773	31,593	49,174	29,376	19,798	6	37,792	9,419	17,000	11,373	107,186	90,186	17,000	11,379	6	11,373
1971	120,574	83,061	32,030	51,025	30,425	20,600	6	37,513	9,744	16,500	11,269	109,299	92,799	16,500	11,275	6	11,269
1972	122,443	85,354	32,461	52,887	31,516	21,371	6	37,089	9,894	16,200	10,995	111,442	95,242	16,200	11,001	6	10,995
1973	124,553	87,336	32,875	54,455	32,619	21,836	6	37,217	10,136	16,100	10,981	113,566	97,466	16,100	10,987	6	10,981
1974	126,649	89,429	33,433	55,990	33,594	22,396	6	37,220	10,357	15,900	10,963	115,680	99,780	15,900	10,969	6	10,963
1975	128,173	91,645	34,054	57,585	34,565	23,020	6	36,528	10,521	15,400	10,607	117,560	102,160	15,400	10,613	6	10,607

1976	129,199	93,474	34,815	58,653	35,265	23,388	6	35,725	10,767	15,000	9,958	119,235	104,235	15,000	9,964	6	9,958
1977	131,311	95,400	35,417	59,977	36,116	23,861	6	35,911	10,999	14,600	10,312	120,993	106,393	14,600	10,318	6	10,312
1978	133,267	97,364	36,014	61,344	36,999	24,345	6	35,903	11,258	14,300	10,345	122,916	108,616	14,300	10,351	6	10,345
1979	134,856	99,217	36,496	62,715	37,968	24,747	6	35,639	11,381	13,900	10,358	124,492	110,592	13,900	10,364	6	10,358
1980	136,350	100,854	36,891	63,957	38,865	25,092	6	35,496	11,650	13,500	10,346	125,998	112,498	13,500	10,352	6	10,346
1981	137,620	102,153	37,236	64,911	39,530	25,381	6	35,467	11,814	13,200	10,453	127,161	113,961	13,200	10,459	6	10,453
1982	139,054	103,150	37,610	65,534	39,944	25,590	6	35,904	12,019	13,100	10,785	128,263	115,163	13,100	10,791	6	10,785
1983	139,940	103,893	37,830	66,057	40,309	25,748	6	36,047	12,165	13,000	10,882	129,052	116,052	13,000	10,888	6	10,882
1984	140,459	104,629	37,957	66,666	40,784	25,882	6	35,830	12,206	13,000	10,624	129,829	116,829	13,000	10,630	6	10,624
1985	140,967	105,564	38,103	67,455	41,336	26,119	6	35,403	12,240	12,800	10,363	130,598	117,798	12,800	10,369	6	10,363

[1] Includes trade, public dining, material-technical supply and sales, and procurement; housing-communal economy and personal services; health services; education and culture; art; science and scientific services; credit and insurance organizations; and government administration.

[2] Includes construction, forestry, transport, communications, and other.

Source: Rapawy and Kingkade, forthcoming.

Collective farm employment is published regularly and has not been affected by reclassification. The employment has been declining steadily in large part due to conversion of collective farms to state farms. Employment in private agriculture has been estimated. The estimates are based on 1958 labor inputs for the cultivation of land and tending livestock.[29] Statistics on the amount of land cultivated privately and on livestock are rported in the statisitical handbooks. Figures include individuals working full-time and part-time. A substantial portion of this employment includes individuals who are employed elsewhere full-time. Approximately two-thirds of the labor is spent on raising livestock. In 1960 the producer cooperatives, with employment of 1.4 million, were abolished and incorporated into the state sector.[30] A small share of unattached artisana still continue working.

WORK-HOUR EMPLOYMENT

Work-hour employment is based on the number of hours worked annually per annual average employee. Work-hour data are extremely sparse and a considerable amount of estimation is required. Figures for the major branches of industry were published only from 1970 to 1975. Work-hour employment for the years prior to 1970 was estimated by an index on actual workweek for wage workers. Employment for the years since 1975 was estimated based on output and productiviey rates. Industry employment is used to estimate most of the employment in nonagricultural branches of the economy based on their relationship of scheduled workweek for wage workers to that in industry.

Table 6 presents work-hour employment for total and selected industries. Work-hour employment in industry increased 117 percent compared to the 149 percent increase in annual average employment. The lower rate of increase is attributable partially to the reduction of the workweek from 48 to 41 hours between 1956 and 1960. During the period from 1956 to 1960 the annual average employment increased 11.9 percent compared to 7.2 percent in work-hour employment. Since 1975 work-hour employment has increased at a slightly lower rate than annual average employment. This may have been caused by the growing share of part-time workers and the reduction of hours worked in the coal industry.

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[29] John W. De Pauw, *Measures of Agricultural Employment in the U.S.S.R.: 1950–66*, International Population Reports, Series P-95, No. 65, Washington, D.C.: Department of Commerce, Bureau of the Census, Foreign Demographic Analysis Division, 1968, pp. 45–46.

[30] Tsentral'noye statisticheskoye upravleniye (TsSU) pri Sovete Ministrov SSSR, *Narodnoye khozyaystvo SSSR v 1960 godu; statisticheskiy yezhegodnik*, Moscow: Statistika, 1961, p. 636.

TABLE 6.—ESTIMATES OF WORK-HOUR EMPLOYMENT IN SELECTED BRANCHES OF INDUSTRY IN THE U.S.S.R.: 1950 TO 1985

[In millions of work-hours]

Year	Total industry	Electric power	Fuels					Chemical and petrochemical		Ferrous metallurgy	Nonferrous metallurgy	Machine-building and metal-working	Construc-tion materials	Timber, woodworking, and pulp and paper		Light industry	Food industry	Other branches
			Total	Coal	Oil extraction	Oil refining	Gas	Total	Chemical					Total	Pulp and paper			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)[a]	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
1950	33,054	405	2,674	1,846	147	95	19	969	766	1,606	667	9,295	1,528	4,765	306	5,630	3,746	1,770
1951	34,927	432	2,758	1,875	151	108	19	1,018	814	1,682	697	9,759	1,650	4,881	314	5,882	3,830	2,337
1952	36,209	462	2,843	1,904	163	116	19	1,071	859	1,757	728	10,247	1,781	4,998	321	6,146	3,914	2,263
1953	37,736	494	2,929	1,975	174	127	19	1,126	909	1,824	756	10,770	1,925	5,124	330	6,430	4,005	2,354
1954	39,569	528	3,017	2,100	165	141	17	1,186	956	1,867	774	11,324	2,080	5,256	338	6,730	4,098	2,711
1955	40,531	566	3,100	2,226	175	156	19	1,247	1,002	1,906	791	11,881	2,247	5,389	348	7,027	4,192	2,184
1956	41,020	602	3,165	2,344	173	167	21	1,283	1,004	1,913	792	12,213	2,381	5,329	344	7,086	4,231	2,025
1957	41,386	644	3,062	2,277	170	175	27	1,339	1,021	1,909	792	12,458	2,527	5,418	349	6,992	4,328	1,916
1958	42,393	638	3,105	2,315	179	183	37	1,277	946	1,787	741	13,303	2,728	5,436	350	7,501	4,466	1,410
1959	42,560	677	2,859	2,147	167	179	35	1,317	990	1,817	753	13,397	2,885	5,429	349	7,640	4,529	1,257
1960	42,752	769	2,731	2,052	161	180	34	1,405	1,070	1,931	800	13,333	3,015	5,293	343	7,394	4,449	1,629
1961	43,061	784	2,579	1,922	158	180	33	1,521	1,153	1,977	842	13,986	2,934	4,971	333	7,110	4,274	2,084
1962	44,616	835	2,540	1,908	160	187	35	1,667	1,279	2,035	898	14,909	2,984	5,014	346	7,242	4,400	2,093
1963	45,897	885	2,567	1,897	160	194	36	1,822	1,443	2,101	951	15,857	3,028	5,049	360	7,233	4,474	1,931
1964	47,713	945	2,613	1,919	168	204	42	2,007	1,582	2,182	1,012	16,988	3,095	5,120	376	7,516	4,707	1,529
1965	49,377	999	2,624	1,960	170	210	45	2,181	1,695	2,230	1,059	17,944	3,127	5,122	390	7,703	4,879	1,509
1966	51,553	1,080	2,692	2,008	180	211	49	2,364	1,814	2,295	1,084	18,935	3,249	5,162	434	8,018	5,070	1,604
1967	53,389	1,122	2,712	2,017	186	211	51	2,490	1,911	2,365	1,112	19,664	3,363	5,156	454	8,364	5,285	1,757
1968	55,288	1,164	2,737	2,005	184	212	51	2,585	1,985	2,422	1,130	20,602	3,499	5,219	466	8,651	5,484	1,795
1969	56,741	1,185	2,690	1,965	185	214	51	2,688	2,063	2,455	1,153	21,409	3,606	5,185	472	8,876	5,530	1,963
1970	57,405	1,187	2,649	1,898	186	214	53	2,771	2,126	2,457	1,166	21,891	3,689	5,211	479	9,096	5,484	1,809
1971	58,554	1,214	2,634	1,875	187	215	55	2,834	2,197	2,457	1,167	22,641	3,785	5,203	484	9,184	5,548	1,897
1972	59,217	1,217	2,553	1,796	189	214	57	2,863	2,203	2,451	1,162	23,168	3,817	5,142	486	9,084	5,571	2,183
1973	59,557	1,220	2,498	1,746	189	215	58	2,922	2,234	2,442	1,160	23,638	3,825	5,097	487	9,056	5,566	2,171
1974	60,725	1,244	2,487	1,727	190	217	62	3,000	2,284	2,469	1,171	24,397	3,893	5,082	492	9,138	5,658	2,191
1975	61,737	1,277	2,489	1,729	189	219	66	3,084	2,348	2,468	1,175	25,147	3,949	5,069	497	9,124	5,683	2,285
1976	63,074	1,306	2,481	1,699	193	222	67	3,156	2,403	2,519	1,199	26,017	4,011	5,070	509	9,326	5,734	2,256
1977	64,018	1,338	2,402	1,632	195	224	67	3,172	2,443	2,549	1,215	26,633	4,077	5,060	508	9,390	5,851	2,331
1978	64,818	1,365	2,454	1,676	198	225	71	3,262	2,500	2,558	1,218	27,058	4,090	5,080	513	9,418	5,871	2,444

TABLE 6.—ESTIMATES OF WORK-HOUR EMPLOYMENT IN SELECTED BRANCHES OF INDUSTRY IN THE U.S.S.R.: 1950 TO 1985—Continued

[In millions of work-hours]

Year	Total industry	Electric power	Fuels					Chemical and petrochemical		Ferrous metallurgy	Nonferrous metallurgy	Machine-building and metal-working	Construc-tion materials	Timber, woodworking, and pulp and paper		Light industry	Food industry	Other branches
			Total	Coal	Oil extraction	Oil refining	Gas	Total	Chemical					Total	Pulp and paper			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
1979	65,534	1,397	2,516	1,720	199	224	72	3,281	2,536	2,554	1,217	27,523	4,123	5,072	517	9,402	5,916	2,532
1980	66,068	1,441	2,540	1,737	200	225	74	3,328	2,566	2,558	1,219	27,841	4,127	5,034	532	9,410	5,924	2,645
1981	66,511	1,463	2,571	1,754	207	227	76	3,360	2,559	2,560	1,219	28,010	4,130	5,046	532	9,456	5,941	2,756
1982	67,033	1,503	2,627	1,797	212	228	75	3,382	2,591	2,602	1,239	28,236	4,190	5,027	538	9,414	5,939	2,874
1983	67,322	1,532	2,551	1,739	216	227	77	3,411	2,618	2,609	1,244	28,465	4,230	5,043	539	9,400	5,948	2,891
1984	67,653	1,563	2,564	1,738	221	227	77	3,416	2,640	2,603	1,240	28,706	4,236	5,009	540	9,326	5,963	3,027
1985	67,954	1,599	2,590	1,732	227	227	79	3,441	2,631	2,627	1,252	28,901	4,231	5,025	539	9,229	5,937	3,122

Source: Rapawy and Kingkade, forthcoming.

Table 7 presents estimated work-hour employment for nonagricultural branches of the economy, excluding industry. In general, employment was estimated by deriving a ratio between the scheduled workweek for industry and other branches in 1968. The ratios were multiplied by the number of hours worked each year in industry per annual average employee.[31] The annual average employment for these branches increased 211 percent compared to 162 percent increase in work-hour employment. The differential growth between the two sets of data was caused by reduction of the length of the workweek and more extensive use of part-time workers in recent years. In addition, annual average employment has been increasing at a faster rate in health and education than for economy as a whole, because about half of the employees in health and education work less than a 41-hour week.

[31] Rapawy and Kingkade, forthcoming.

TABLE 7.—ESTIMATES OF WORK-HOUR EMPLOYMENT IN SELECTED NONAGRICULTURAL BRANCHES OF THE ECONOMY IN THE U.S.S.R.: 1950 TO 1985

[In millions of work-hours]

Year	Total	Construction	Forestry	Transport	Communications	Trade public dining, material technical supply, and procurement	Housing-communal economy and personal services	Health services	Education and culture	Art	Science and scientific services	Credit and insurance organizations	Government administration	Other
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
1950	44,359	6,756	960	8,947	1,170	7,302	2,965	3,887	5,466	400	1,538	571	3,979	419
1951	45,963	7,043	977	9,470	1,192	7,463	3,079	4,047	5,649	418	1,639	567	3,920	498
1952	47,541	7,389	993	9,990	1,212	7,624	3,193	4,205	5,834	434	1,737	563	3,860	505
1953	48,288	7,617	893	10,341	1,247	7,541	3,260	4,358	5,981	453	1,774	564	3,723	537
1954	49,903	8,408	862	10,608	1,275	7,810	3,324	4,655	6,252	469	1,849	566	3,326	499
1955	50,942	8,530	832	10,870	1,304	8,075	3,386	4,949	6,524	488	1,952	567	2,926	537
1956	51,966	9,390	814	10,969	1,299	8,021	3,476	5,089	6,594	511	2,088	555	2,814	346
1957	53,530	10,429	768	10,990	1,303	8,224	3,506	5,315	6,719	536	2,216	532	2,649	344
1958	56,309	11,452	742	11,550	1,341	8,519	3,548	5,601	6,887	566	2,454	526	2,631	492
1959	57,954	11,937	693	11,835	1,357	8,680	3,572	5,860	7,030	586	2,644	512	2,518	730
1960	59,594	12,309	680	11,950	1,395	8,898	3,636	6,133	7,219	597	3,003	502	2,370	903
1961	60,682	12,297	685	11,867	1,428	9,121	3,678	6,380	7,531	627	3,286	502	2,358	924
1962	62,398	11,852	705	12,157	1,504	9,564	3,797	6,624	8,050	616	3,634	513	2,396	987
1963	64,545	12,118	721	12,428	1,582	9,968	3,944	6,816	8,496	638	3,901	522	2,376	1,034
1964	67,671	12,541	734	12,878	1,682	10,501	4,146	7,090	9,064	658	4,140	538	2,472	1,226
1965	70,610	13,200	725	13,138	1,812	10,886	4,301	7,399	9,590	667	4,311	541	2,645	1,397
1966	73,595	13,717	741	13,407	1,940	11,399	4,509	7,681	10,063	688	4,533	567	2,802	1,547
1967	76,742	14,357	748	13,632	2,036	12,004	4,858	7,895	10,502	703	5,744	598	2,985	1,680
1968	80,003	14,880	766	13,917	2,157	12,742	5,098	8,255	11,019	716	5,005	630	3,131	1,688
1969	83,518	15,687	777	14,309	2,311	13,363	5,346	8,573	11,445	735	5,258	662	3,299	1,753
1970	86,407	16,529	788	14,610	2,417	13,791	5,557	8,834	11,806	750	5,438	706	3,363	1,817
1971	90,175	17,542	791	15,100	2,548	14,388	5,885	9,137	12,204	769	5,708	753	3,477	1,872
1972	93,314	18,304	810	15,513	2,617	14,878	6,170	9,382	12,514	782	6,002	802	3,600	1,939
1973	95,513	18,376	806	15,884	2,655	15,313	6,404	9,586	12,788	788	6,300	844	3,715	2,053
1974	98,416	18,873	817	16,316	2,722	15,800	6,667	9,828	13,124	802	6,541	897	3,868	2,160
1975	101,093	19,266	823	16,824	2,770	16,170	6,912	10,021	13,431	810	6,858	943	3,995	2,271
1976	102,882	19,511	815	17,109	2,817	16,438	7,072	10,203	13,714	813	6,979	991	4,077	2,342
1977	104,962	19,765	819	17,490	2,847	16,753	7,328	10,325	14,018	813	7,160	1,040	4,168	2,436
1978	106,872	19,958	826	17,876	2,878	16,966	7,607	10,403	14,383	813	7,309	1,089	4,256	2,509

1979	109,007	20,132	824	18,281	2,896	17,225	7,834	10,661	14,658	820	7,641	1,137	4,360	2,537
1980	110,834	20,230	822	18,619	2,926	17,482	8,097	10,678	15,093	820	7,827	1,165	4,500	2,577
1981	112,183	20,282	822	18,928	2,945	17,678	8,188	10,833	15,318	827	7,981	1,185	4,598	2,599
1982	112,982	20,239	820	19,152	2,969	17,702	8,237	11,011	15,538	827	7,960	1,207	4,650	2,670
1983	113,698	20,237	818	19,290	2,979	17,722	8,372	11,198	15,662	820	7,941	1,214	4,706	2,739
1984	114,904	20,329	816	19,411	2,980	17,866	8,546	11,393	15,896	818	8,019	1,222	4,771	2,838
1985	116,304	20,598	815	19,536	2,980	18,015	8,746	11,592	16,204	818	8,106	1,213	4,783	2,899

Source: Rapawy and Kingkade, forthcoming

Total estimated work-hour employment in the Soviet economy is given in Table 8. Figures are sums of nonagricultural employment, already discussed and employment in agriculture. Agricultural employment is derived by estimating number of days worked annually and multiplied by the hours worked daily. In state agriculture the number of days worked annually per person were estimated for the early years.[32] The number of days worked since 1960 was derived from the wage figures reported in statistical handbooks. Comparable data for collective farms were estimated for the years 1960 to 1985 based on reported wage data; figures for 1950 were assumed to be the same as those for 1960. The number of days worked annually per person in state agriculture ranged between 275 and 280 days, with few exceptions. The number of days worked on collective farms annually is 10 to 20 days lower than that for the state farms.[33]

TABLE 8.—ESTIMATES OF WORK-HOUR EMPLOYMENT IN THE U.S.S.R. BY SECTOR: 1950 TO 1985

[In millions of work-hours]

Year	Total	Nonagricultural sectors				Agricultural sectors			
		Total	Industry	Other	Independent artisans	Total	State	Collective farm	Private
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1950	157,043	78,768	33,054	44,359	1,355	78,275	7,699	47,064	23,513
1951	156,861	82,125	34,927	45,963	1,235	74,736	8,006	45,926	20,804
1952	157,682	84,866	36,209	47,541	1,116	72,815	8,313	44,790	19,712
1953	161,068	87,022	37,736	48,288	998	74,047	9,085	43,653	21,308
1954	169,328	90,354	39,569	49,903	881	78,974	13,498	42,971	22,505
1955	172,203	92,237	40,531	50,942	764	79,966	13,702	42,289	23,975
1956	175,499	93,618	41,020	51,966	633	81,881	13,536	43,824	24,521
1957	176,439	95,424	41,386	53,530	508	81,015	15,107	41,436	24,472
1958	179,975	99,100	42,393	56,309	398	80,875	13,720	42,459	24,696
1959	178,167	100,870	42,560	57,954	355	77,297	12,980	41,777	22,540
1960	177,624	102,657	42,752	59,594	312	74,967	15,577	38,026	21,364
1961	176,221	104,013	43,061	60,682	269	72,208	15,108	35,037	22,064
1962	178,630	107,255	44,616	62,398	240	71,376	15,824	33,418	22,134
1963	180,022	110,653	45,897	64,545	211	69,369	16,033	32,049	21,287
1964	185,125	115,566	47,713	67,671	183	69,559	16,395	31,786	21,378
1965	191,637	120,140	49,377	70,610	153	71,496	17,399	30,552	23,576
1966	196,522	125,273	51,553	73,595	125	71,249	17,626	29,529	24,094
1967	200,359	130,227	53,389	76,742	96	70,132	17,588	29,199	23,345
1968	204,132	135,358	55,288	80,003	67	68,774	17,407	28,596	22,771
1969	207,524	140,298	56,741	83,518	40	67,225	17,611	27,746	21,868
1970	211,556	143,823	57,405	86,407	11	67,733	18,039	27,406	22,288
1971	216,469	148,740	58,554	90,175	11	67,729	18,744	26,900	22,085
1972	219,867	152,542	59,217	93,314	11	67,325	19,032	26,740	21,553
1973	223,056	155,080	59,557	95,513	11	67,975	19,583	26,868	21,525
1974	227,586	159,152	60,725	98,416	11	68,434	20,010	26,935	21,490
1975	230,306	162,841	61,737	101,093	11	67,465	20,415	26,260	20,790
1976	232,422	165,968	63,074	102,882	11	66,455	20,983	25,956	19,516
1977	235,929	168,992	64,018	104,962	11	66,938	21,342	25,386	20,209
1978	239,050	171,700	64,818	106,872	11	67,349	21,845	25,225	20,279
1979	241,593	174,552	65,534	109,007	11	67,041	21,988	24,753	20,300
1980	244,065	176,913	66,068	110,834	11	67,152	22,606	24,268	20,279
1981	246,167	178,705	66,511	112,183	11	67,462	23,023	23,950	20,489
1982	248,577	180,026	67,033	112,982	11	68,551	23,423	23,989	21,140
1983	250,309	181,030	67,322	113,698	11	69,279	23,707	24,242	21,329

[32] De Pauw, 1968, pp. 38–39.
[33] Rapawy and Kingkade, forthcoming.

TABLE 8.—ESTIMATES OF WORK-HOUR EMPLOYMENT IN THE U.S.S.R. BY SECTOR: 1950 TO 1985—Continued

[In millions of work-hours]

Year	Total	Nonagricultural sectors				Agricultural sectors			
		Total	Industry	Other	Independent artisans	Total	State	Collective farm	Private
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1984	251,532	182,568	67,653	114,904	11	68,964	23,787	24,352	20,825
1985	252,417	184,268	67,954	116,304	11	68,149	23,750	24,084	20,314

Source: Rapawy and Kingkade, forthcoming.

Workday estimates for state agriculture were converted to work-hours by assuming an 8-hour day for the years 1950 to 1960 and a 7-hour day thereafter. Reportedly the 8-hour day was in effect until 1960.[34] A number of Soviet sources claim that after 1960 average workday amounted to about 7 hours. The workday employment on collective farms was converted to work-hours by assuming a 7-hour day for the entire period, based on information in Soviet sources.[35] The 7-hour day was also assumed for private agriculture as the labor inputs are based on the survey of collective farm households. And figures are given, in days, for comparable activities spent on collective farms and in private agriculture. The work-day in both sectors had to be of similar duration for the comparison to have any validity.

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[34] Nancy Nimitz, *Farm Employment in the Soviet Union, 1928–1963*, RAND Memorandum RM–4623–PR, Santa Monica, Calif.: The Rand Corporation, November 1965, p. 140.

[35] For example see, M.I. Sidorova, *Vozmeshcheniye neobkhodimykh zatrat i formirovaniye fonda vosproizvodstva rabochey sily v kolkhozakh. Metodologiye, uroven', istochniki*, Moscow: Nauka, 1972, p. 157.

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ROOTS OF GORBACHEV'S PROBLEMS: PRIVATE INCOME AND OUTLAY IN THE LATE 1970S

By Gregory Grossman [1]

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I. Summary

Because Soviet sources reveal almost no comprehensive quantitative data on private (non-socialist, informal, illegal household) incomes and expenditures, the author and Professor V.G. Treml have jointly conducted to this end a questionnaire survey among recent Soviet immigrants into the U.S. Our still partial and tentative (and not yet re-weighted) findings show such private incomes and outlays to have been of fairly large magnitude in the second half of the 1970's, the years to which our findings relate. However, there is a great variation by geographic location, city type, family, and other characteristics. Thus, for full, working families in Leningrad, per capita private income (AOI) on average adds 38 percent to "legitimate socialist income" (LSI), for the same type of family in the European southwest (Belorussia, Moldavia, Ukraine)—67 percent, and for ethnic Armenians in Armenia—as much as 179 percent (i.e., the addition of AOI almost triples LSI). Private purchases and payments per capita tend, on the average, to be close to the AOI values for the individual groups; but within groups, they tend to rise more slowly than private income. Legitimate socialist income tends to be a poor predictor of both private income and private expenditures, suggesting that involvement in the second economy tends to cut across all income strata of a given geographic or demo-

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graphic group, (though the limitations of our sample at both extremes of the income distribution must be borne in mind in this connection). All indications are that between the 1970's, to which our findings relate, and the accession of Mr. Gorbachev to power, both private income and private expenditure rose considerably, both absolutely and relative to LSI. Superimposed on the findings of our survey, this fact helps explain the high attention accorded by the Gorbachev administration to both negative and positive measures in regard to the second economy.

II. Introduction

Few problem areas have occupied as much of Mr. Gorbachev's attention in the two years since his accession to the General Secretaryship of the CPSU as that of the second economy and such related matters as corruption, economic crime, the distinction between "labor" and "non-labor" income, and the morals of the Soviet Man as producer and consumer. Two major pieces of legislation at the union level have appeared as of this writing: The law of 23 May 1986 aimed at stiffening the fight against non-labor incomes and the attendant economic crimes, and that of 19 November 1986 aimed at redefining the norms and the prohibited and permitted spheres of "individual [private] labor activity" (ILA). The law on ILA—which is to go into effect on 1 May 1987 and will surely be supplemented by republic-level laws, local ordinances, and innumerable instructions, regulations, and directives by various authorities on all levels of government and law-enforcement—is clearly intended as much to bring into the open some of the hitherto submerged (underground) production of consumer goods and services as to promote altogether new private activity. A third piece of legislation, on producers' cooperatives in the realm of consumer goods and services, has been repeatedly indicated by authoritative Soviet sources but has not yet been enacted at this writing.

At the same time, the Soviet press has been carrying an unbroken series of almost daily accounts of arrests, trials, and convictions of individuals and groups of persons for violations of laws against corruption and other kinds of economic crime. Capital punishment has been meted out in a number of announced (and how many unannounced?) instances. The publicized cases of law enforcement cover the broadest range of economic branches, involve the mighty as well as the humble (i.e., humble in terms of official position if not in the magnitude of the alleged crime), and refer to every part of the Soviet Union.

The Gorbachev wave of arrests and convictions for economic crime may well be one of the largest such waves, if not the largest, of the post-Stalin period. It does not want for targets. After over half a century of the Stalinist economic system—and particularly after almost two decades of the Brezhnev era—almost anybody who is somebody, and tens of millions who are essentially nobody, are criminalized by "life itself" (as the Soviets would say), by just doing their jobs and trying to live, not to speak of the (not so?) few who have waxed rich on illicit income (cf. Grossman 1977 and 1979, Millar 1985). The important question in connection with the latest wave of arrests and convictions therefore is: Since all the guilty

ones cannot be jailed in a short span of time, what are the criteria and mechanisms that select those that are, and consequently to what extent is this campaign more than one of mere law-enforcement, but also a political purge and a settling of accounts on every societal level?

The object of the present paper is, however, not to address this question but rather to provide a very limited empirical picture of the extent and depth of certain "private" income and "private" expenditure in the Soviet economy shortly before Mr. Gorbachev's accession to power. Specifically, it will present our estimates of the relative importance of private income and private outlay (on current account only) by households in several important geographic areas of the USSR during the later years of the Brezhnev era. There will follow brief attempts at qualifying and interpreting our findings and at assessing their trends up to the beginning of the Gorbachev era. In this modest way, it is hoped, our research will throw some light on the difficult problems that Gorbachev has faced and on the—often drastic—measures that he has taken so far.

Virtually no reliable (or even unreliable) comprehensive or systematic estimates of private incomes and outlays of the Soviet population are to be found in Soviet sources, official or otherwise. Even the sparse household budgets that are regularly published in the official statistical yearbooks omit any mention of the informal transactions of the urban population. And yet, as the Soviet press and literature themselves amply inform us, private (or, "left") incomes and outlays—that is to say, incomes derived and expenditures made in non-official, informal, and illegal ways—constitute a significant part of the daily reality of the average Soviet household. The data that follow derive from a questionnaire survey of over 1,061 Soviet emigrant families (comprising 3,023 individuals) conducted in the United States jointly by Professor V. G. Treml and the present author. (The survey is briefly described in the Appendix to this paper.) The survey sample was drawn solely from former Soviet urban dwellers, with heavy emphasis on the European RSFSR and Armenia, and relates essentially to the second half of the 1970's. The figures herein presented have not yet been normalized (re-weighted) to better represent the "parent" urban population of the USSR.

Within the just-mentioned limitations, this paper attempts, as it were, to reconstruct a missing portion of the household segment of the national accounts of the Soviet Union for the period in question, thereby hoping to fill—at least partially and with all the imperfections of questionnaire surveys among emigres [2]—some of the large lacunae in the official data. In the process, we also attempt to point to certain noteworthy relationships and features within the private sector of the Soviet economy (the second economy).

We begin by explaining the concepts and terms employed herein, proceed with the presentation of four summary tables, and devote

[2] We are here alluding to the problems of recall, "refugee bias", semantics, reaction to the host country, nationality, etc., which have been discussed by us and others and will not be taken up at length here. See, for example, Millar (1986). Suffice it to say here that we do not believe the problems of bias to be overly serious in our survey, in part because of the focus on everyday-type of matters in the questionnaire.

the last part of the paper to a discussion and interpretation of the tabulated data. As mentioned, the Appendix contains a brief description of the questionnaire survey whose, still preliminary, results form the data base for the present paper.

III. Concepts, Terms, and Abbreviations

N—number of persons (not households)

Household (family) types:

Full, working (F-W) households are those in which both members of the central couple are present and at least one working in the official sector.

Pensioner households consist of pensioners only; in our sample, almost always two pensioners per household. Note that pensioners may also be included in F-W households.[3]

Locational categories:

The sample is deliberately limited to households that resided in urban places before emigration.

North—portions of the USSR that lie north of the Caucasus range and of Central Asia, inclusive of northern Kazakhstan (almost unrepresented in the sample).

South—Transcaucasia and Central Asia, including southern Kazakhstan.

Bel, Mol, Ukr.—jointly, the republics of Belorussia, Moldavia, and Ukraine. In this region, the second economy appears to be considerably more developed relative to official incomes than in

RSFSR, Baltics—which comprises jointly the republics of R.S.F.S.R., Estonia, Latvia, and Lithuania.

Eastern RSFSR—is the portion of the RSFSR lying to the east of Moscow and Leningrad *oblasti* and between Moscow *oblast'* and the North Caucasus Region. It excludes the Far North and the Far East (with their high official wages), and in fact also excludes the regions of Eastern and Western Siberia for want of but a few households in our sample. Eastern RSFSR is reputed to be a relatively poor area in terms of total personal income and, especially, private income, as indeed our figures tend to confirm.

AA—Armenians from Armenia. (In addition, our over-all sample also contains 20 families of non-Armenians who lived in Armenia before emigration but originally hailed from the North. The *non*-Armenians from Armenia have a very different economic profile from the AA and, hence, are included in the next category.)

SRNAA—emigrants from southern republics other than AA. These are ethnic "northerners" who lived in one or another southern republic in the given year. Southern Kazakhstan is included in this category. (For numbers from individual republics see Appendix Table A.)

Time period:

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[3] In addition to F-W and pensioner households, our sample includes households of single females, single males, and single females with children (usually one). Virtually all these households are from Leningrad. They are not considered in this paper in the interest of brevity.

Respondents were asked to report on the "last normal year" (LNY), i.e., the last full calendar year of the household's residence in the USSR which was not affected by the decision to emigrate. For the sample as a whole, LNYs range from 1970 through 1981, but 98 percent of them fall between 1974 and 1980, and 85 percent—between 1976 and 1979, inclusive. Both median and mean LNYs are 1977.

Indexing: To adjust for the steady growth in average official wages, not to speak of consumer prices of most kinds and in most markets, all ruble values on both the income and the expenditure side were brought to the "1977 level" by dividing absolute amounts by the given year's index of the average monthly gross wage for the USSR as a whole, 1977=100 percent. Examples (percent): 1974—90.9, 1977—100, 1979—105.2.

Income categories:

All categories relate only to *personal* (household) income on *current* account, including both factor earnings and transfers of all kinds, legal and illegal (including theft). In-kind income, primarily from private gardens and orchards (which may be in principle legal) and from theft, is evaluated by respondents themselves. In-kind income appears equivalently as in-kind expenditure in our accounts. Non-cash benefits from what the Soviets call the "social consumption fund"—in-kind benefits distributed by the state, such as educational or medical services, and subsidies to prices of consumer goods and housing and other services—are not here included in income. Also not included are (1) imputed rent of owner-occupied dwellings and of other real estate and major consumer durables, and (2) implicit income from "connections" *(blat)* and the like (which are treated in our "Informal Personal Incomes and Outlays of the Soviet Population"; forthcoming, see References).

TPI—total personal income per capita (i.e., per household member).

LSI—legitimate socialist income per capita, i.e., that part of TPI which is formally (officially, legally) obtained from the socialist sector, mainly from the state. Amounts are *net* of direct taxes withheld by employer. LSI includes legally sanctioned non-labor income, such as interest on savings in the savings bank, official transfer payments (e.g., student stipends, old age pensions), as well as labor earnings from employment in a state or other socialist unit. However, LSI does *not* include income earned by way of contractual relationship with a socialist entity by persons ("vendors") acting in a self-employed capacity (e.g., free-lance artists, *neshtatnye, shabashniki, starateli*).[4] In our sample, vendor income is rather small, but much more lucrative per hour than official wages.

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[4] Such contractual arrangements can be legal, and when so, cover a wide range of activities and are often of considerable advantage to the individual in terms of earnings and otherwise. Also widespread and often even more lucrative are illegal (or "semi-legal") contractual arrangements, individual or collective, especially common in construction *(shabashniki)*.

AOI—all other income per capita, defined as TPI *minus* LSI. As such it includes: (i) illicit income from the socialist sector, (ii) all earnings or transfer income from the household sector, in money or in kind, legal or illegal, (iii) home-grown food, (iv) vendor income (as above), and (v) income from abroad. For any large value of AOI, (i) and (ii) are likely to be much more important than (iii)–(v).

Age, education, and blue-collar percentage: Age and education level refer only to husband and wife in a given family, in LNY. Blue-collar percentage is the percentage of blue-collar workers *(rabochie)* in the sum of blue-collar workers and white-collar employees, taking account only of each household's central couple (husband, wife), as self-identified by each person.

TPCP—total private consumption and payments. Comprises purchases and payments other than official or formal ones from/to socialist entities. Includes purchases from private persons, self-produced food for own consumption, and in-kind private receipts of goods and services. Also includes services "purchased" with bribes and tips at the value indicated by respondent. Does *not* include imputed rent of owner-used real estate or major durables, or the implicit value of connections helpful in obtaining favors and scarce goods in LNY.

A serious problem of underestimation of TPCP and of its individual components (such as food purchases, immediately below) arises from the widespread existence in the Soviet Union of what we have termed "crypto-private" activity, that is, private economic activity that hides behind the facade of a legitimate socialist enterprise (cf. Grossman 1979). The products of crypto-private activity are often indistinguishable, physically and by price, from identical products sold on the state's account, the two kinds being sold side by side. While this arrangement helps the private operation from discovery by authorities, it also prevents the buyer from realizing that he is buying private and not socialist goods. Our respondents would, presumably, fail to report such purchases as private, and to this—unknown—extent TPCP is understated.

TPCP for cash—TPCP less the in-kind items just mentioned.

Private food for cash—refers to food purchases from (i) private sellers in organized peasants' markets *[kolkhoz markets]* (but see qualification below), (ii) individual sellers outside organized markets, and (iii) private persons while at a summer house in the countryside. The small fraction of purchases at peasant markets bought from socialist entities rather than private persons is not deducted here. This overstatement may be more than offset by the just-mentioned crypto-private sales of foodstuffs.

Saving (in the given year) is the amount reported by the respondent.

mFi—mean of the *i*th fifth of an array.

TABLE 1.—MEANS OF PERSONAL INCOME PER CAPITA AND ITS MAJOR COMPONENTS BY HOUSEHOLD TYPE AND LOCATION

[Rubles per year, except as noted, values indexed to 1977 unreweighted]

	Groups	Total personal income (TPI)	Legitimate income from Socialist sources (LSI)	All other ("private") income (AOI)	TPI LSI	AOI/TPI (percent)	Education, years/ percent blue-collar
		(1)	(2)	(3)	(4)	(5)	(6)
	Full working households (F-W):						
1.	North (N = 1,609)	1,948	1,291	657	1.51	33.7	11.9/19.4
		(100)	(100)	(100)			
	Of which:						
2.	Bel, Mol, Ukr. (558)	2,174	1,300	874	1.67	40.2	11.2/34.3
		(112)	(101)	(133)			
3.	RSFSR, Baltics (1,051)	1,828	1,287	541	1.42	29.6	12.2/23.5
		(94)	(100)	(82)			
	Of which:						
4.	Moscow (166)	2,408	1,643	764	1.47	31.7	13.3/12.2
		(124)	(127)	(116)			
5.	Leningrad (294)	1,943	1,405	538	1.38	27.7	13.0/15.7
		(100)	(117)	(82)			
6.	Eastern RSFSR (119)	1,531	1,216	315	1.26	20.6	11.4/35.1
		(79)	(94)	(48)			
7.	AA (Armenia, Armenians only) (560)	3,220	1,155	2,065	2.79	64.1	9.8/44.5
		(165)	(89)	(314)			
8.	SRNAA ("Northerners" in southern republics) (488)	1,783	896	887	1.99	49.7	12.2/17.8
		(92)	(69)	(135)			
	Pensioner households:						
9.	Leningrad (N = 164)	1,241	1,046	195	1.19	15.7	12.4/.....
		(64)	(81)	(30)			
10.	AA (30)	2,839	963	1,876	2.95	66.1	5.65/.....
		(146)	(75)	(286)			

Note: Figures in parentheses are percentages of corresponding values for "North." For further explanation of concepts and terms see text and appendix.

TABLE 2.—COMPARISON OF PRIVATE INCOME (AOI), PRIVATE CONSUMPTION AND EXPENDITURE (TPCP), AND PRIVATE FOOD PURCHASES, ALL PER CAPITA, BY HOUSEHOLD TYPE AND LOCATION

[Rubles per year, values indexed to 1977, unreweighted]

	Groups	AOI	TPCP	TPCP minus AOI (2) − (1)	TPCP for cash	Private food for cash	Ditto as percent of TPCP for cash
		(1)	(2)	(3)	(4)	(5)	(6)
	A. Full working households:						
1.	North (N = 1,609	657	701	44	631	221	35.0
	Of which:						
2.	Bel, Mol, Ukr. (558)	874	880	6	846	328	38.7
3.	RSFSR, Baltics (1,051)	541	605	64	530	164	30.9
	Of which:						
4.	Moscow (166)	764	847	83	750	207	27.6
5.	Leningrad (294)	538	674	136	585	149	25.4
6.	Eastern RSFSR (119)	315	447	132	428	183	42.8
7.	AA (560)	2,065	1,988	−77	1,595	617	38.7
8.	SRNAA (488)	887	921	34	856	391	45.6
	B. Pensioner households:						
9.	Leningrad (N = 164)	195	497	302	449	161	35.9
10.	AA (30)	1,876	2,023	147	1,578	648	41.1
	C. Differences:						
11.	Line 2. minus line 3	333	275	.....	.....	.....	.....

TABLE 2.—COMPARISON OF PRIVATE INCOME (AOI), PRIVATE CONSUMPTION AND EXPENDITURE (TPCP), AND PRIVATE FOOD PURCHASES, ALL PER CAPITA, BY HOUSEHOLD TYPE AND LOCATION—Continued

[Rubles per year, values indexed to 1977, unreweighted]

	Groups	AOI	TPCP	TPCP minus AOI (2) − (1)	TPCP for cash	Private food for cash	Ditto as percent of TPCP for cash
		(1)	(2)	(3)	(4)	(5)	(6)
12.	Line 4, minus line 3	223	242				
13.	Line 5, minus line 6	223	227				
14.	Line 7, minus line 8	1,178	1,067				
15.	Line 8, minus line 1	230	220				
16.	Line 10, minus line 9	1,681	1,526				

Note to table 2: AOI is "all other (i.e., private) income", the difference between total personal income on current account and legitimate income from socialist sources. TPCP is "total private consumption and payments (on current account)", including consumption of goods received in kind and self-produced goods (chiefly food); imputed rentals are not included. "TPCP for cash" and "Private food for cash" exclude the in-kind and self-produced parts of each. For further explanation of concepts and terms see text and appendix.

TABLE 3.—MEAN PER CAPITA VALUES BY LOWEST AND HIGHEST FIFTHS

[Arrayed by TPI; rubles per year unless otherwise noted]

		North			Armenians from Armenia (F-W)		
		mF1	mF5	mF5:mF1	mF1	mF5	mF5:mF1
1.	N (persons)	321	322		112	112	
2.	TPI	942	3,899	4.14	1,050	6,474	6.17
3.	LSI	776	2,129	2.74	705	1,457	2.07
4.	Percent of TPI	82.4	54.6		67.2	22.5	
5.	AOI	165	1,770	10.69	344	5,017	14.58
6.	Percent of TPI	17.6	45.4		32.8	77.5	
7.	TPI:LSI	1.21	1.83		1.49	4.44	
8.	Persons per household	3.69	2.59		4.15	2.54	
9.	Age, yrs	35.5	41.1		38.5	42.8	
10.	Education, yrs	11.7	12.0		9.5	10.4	
11.	Blue collar, percent	27.2	28.2		62.5	29.7	
12.	TPCP	265	1,437	5.42	558	4,157	7.45
13.	Percent of TPI	28.1	36.8		53.1	64.2	
14.	TPCP–AOI	100	−333		214	−860	
15.	Saving	76	583	7.69	193	2,528	13.10
16.	Percent of TPI	8.1	15.0		18.4	39.0	
		P20	P80	P80:P20	P20	P80	P80:P20
17.	TPI percentiles	1,120	2,365	2.11	1,420	4,475	3.15

TABLE 4.—MEAN PER CAPITA VALUES BY LOWEST AND HIGHEST FIFTHS

[Arrayed by TPI; rubles per year unless otherwise noted]

		North: Bel, Mol, Ukr			North: RSFSR, Baltics		
		mF1	mF5	mF5:mF1	mF1	mF5	mF5:mF1
1.	N (persons)	111	112		210	211	
2.	TPI	1,026	4,674	4.56	910	3,454	3.80
3.	LSI	817	2,138	2.62	745	2,113	2.84
4.	Percent of TPI	79.6	45.7		81.9	61.2	
5.	AOI	209	2,536	12.13	164	1,341	8.18
6.	Percent of TPI	20.4	54.3		18.0	38.8	
7.	TPI:LSI	1.26	2.19		1.22	1.63	
8.	Persons per household	3.68	2.55		3.67	2.64	
9.	Age, yrs	33.9	39.9		36.2	41.9	
10.	Education, yrs	11.4	11.2		11.8	12.7	
11.	Blue collar, percent	28.1	33.7		28.2	23.1	
12.	TPCP	440	1,696	3.85	208	1,224	5.88

TABLE 4.—MEAN PER CAPITA VALUES BY LOWEST AND HIGHEST FIFTHS—Continued

[Arrayed by TPI, rubles per year unless otherwise noted]

	North: Bel, Mol, Ukr.			North: RSFSR, Baltics		
	mF1	mF5	mF5:mF1	mF1	mF5	mF5:mF1
13. Percent of TPI	42.8	36.2	.....	22.9	35.4	.....
14. TPCP–AOI	231	−840	.....	44	−117	.....
15. Saving	64	718	11.17	80	480	6.02
16. Percent of TPI	6.2	15.4	.....	8.8	13.9	.....
	P20	P80	P80:P20	P20	P80	P80:P20
17. TPI percentiles	1,277	2,714	2.13	1,111	2,293	2.06

IV. Discussion

This section of the paper does not pretend to anything like a full commentary on the data in the Tables; rather, it limits itself to brief remarks on a few salient points of broader interest.

Unlike the aforementioned Soviet official statistics of non-peasant consumer budgets, our survey, like other such surveys,[5] finds a considerable amount of private income per capita (AOI), which adds from about 20 percent (Leningrad pensioners) to as much as almost 200 percent (Armenians) to the average legitimate socialist income per capita (LSI) of a group (Table 1, lines 7., 9., 10., col. (4)). A less coarse partitioning of our sample would no doubt show an even greater range of private supplements to LSI. This private income rests on a broad range and greatest variety of informal, semi-legal, and illegal actions and transactions. In turn, it generates the demand for much of the output of the second economy. Accordingly—and although the second economy is intimately and functionally intertwined with the "first"—we may speak of a considerable "second (or parallel) circuit" of real and monetary flows within the overall Soviet economy. Some noteworthy features of this parallel circuit will be brought out presently.

A. Regional Variation

A pronounced spatial pattern characterizes the Soviet second economy and private income. Broadly speaking, AOI tends to increase, both absolutely and relative to LSI from north to south and from east to west. For our limited number of cases, Tables 1 and 2 tend to illustrate these geographic gradients of private income.

Any thorough explanation of these gradients falls outside the scope of the present paper, but in any event, attempts at explanation would need to refer to a multiplicity of factors, not all of them strictly economic. But let us venture to speculate about one such factor, local *private* surplus of foodstuffs. Might it be that a local agriculture which—once recovered from its Stalinist depression—becomes capable of producing a surplus of *privately or crypto-privately* marketed foodstuffs for direct sale to the local urban population, presents its potential consumers with the prospect of a much

[5] For preliminary findings on private (informal) income and expenditures see especially Ofer and Vinokur, 1980. Their survey refers to the early 1970's. Possibly for this reason, as well as others, they find lower relative private incomes and outlays than does this study.

improved, if expensive, food supply and for this reason spurs them to greater second-economy activity? A yet larger privately handled surplus of directly marketable foodstuffs seeks out the more lucrative markets farther away—Georgian oranges to Siberia, Uzbek melons to Moscow, Moldavian tomatoes to Leningrad—in the process causing a significant (initial) interregional trade surplus and inflow of cash into the region. In turn, this may create a hidden network of trade and distribution, underground moneyed capital, and a climate of official corruption, which, with time, lay a firm foundation for a much more diverse range of second-economy activities.

Other activities might, of course, also provide an economic base for the germination and growth of a local second economy and private incomes; e.g., consumer-goods industry (with its diversion of products into black markets), important resort-type resources, the perennial northward and eastward migration of construction gangs from Armenia, the northern slopes of the Caucasus, and the Western Ukraine. Finally, significant centers of Party and government administration have their own mechanisms for creating illicit private wealth, both within and outside the formal hierarchy of power. But let us not minimize the potential of *any* nook within the Soviet economy to generate "left" activities and "left" incomes.

But to return to our data. Table 1 shows only the small variation in mean *legitimate socialist income* (LSI) per capita among the regional groups. Moscow and Leningrad averages stand out, as they may be expected to do. But note that the average LSIs of Belorussia, Moldavia, and the Ukraine, on one hand, and of the RSFSR and the Baltic republics, on the other hand, differ by only one percent. Armenia's LSI is lower than those in the North, as official Soviet statistics would have us expect. (The surprisingly very low LSI per capita of the northerners from southern republics [SRNAA] seems to be due to a relatively higher ratio of dependents to breadwinners in our sample—for reasons not clear to us at the moment.) The mean LSI for our total sample of 1,061 families (which include a few smaller groups not listed in the Tables), indexed to 1977 and roughly re-weighted by regions, falls within the range of estimate for the corresponding figure obtainable from official Soviet statistics for 1977.

Private income (AOI) is something else again; it ranges most widely among our groups, from a mean of 195 rubles per year per capita for Leningrad pensioners, and 315 for "Eastern" RSFSR (the agriculturally and otherwise poorer part of the country), through 657 for the North as a whole and 874 for Belorussia-Moldavia-Ukraine, to 2,065 r/yr for AA (Armenians from Armenia, full working families). AOI is also remarkably high for Armenian pensioners, in striking contrast to those in Leningrad. While in the North as a whole LSI income augments by one half again thanks to private income (and in Belorussia, Moldavia, and Ukraine—by two-thirds), the northerners in the south [SRNAA] add almost 100 percent to their LSI in this way, and the Armenians in Armenia—nearly 200 percent.

Since *total* personal income (TPI) equals LSI plus AOI, it varies a good deal regionally, too, but of course relatively less than AOI. TPI ranges (in Table 1) from 1,531 rubles per year per capita in the

relatively poor Eastern RSFSR, through 1,948 for the North as a whole to 3,220 r/yr for the AA (full, working families). Stated otherwise, in the Eastern RSFSR, AOI provides only some 20 percent of total personal income; in Belorussia-Moldavia-Ukraine—some 40 percent, in Armenia (for AA)—almost two-thirds. In this regard, Armenians from Armenia may be rather representative of the indigenous populations of all three Transcaucasian republics. Needless to say, the just-cited figures, even if accurate representations of the "true" levels of per capita income in the given regions at the given time (around 1977), stand only for relative levels of per capita income in money terms. They need not be accurate measures of relative per capita *welfare,* which depends also on relative regional and even " personal" prices, access to real goods and services, and the many other complexities of Soviet consumer reality.[6]

B. PRIVATE INCOME AND PRIVATE EXPENDITURE

Table 2 addresses itself to the relationship between private income (AOI) and "total private consumption and payments" (TPCP), again by groups. First, we note that AOI and TPCP are derived separately from different parts of the questionnaire,[7] and in this sense are independent magnitudes for any one respondent and for any group. Second, theoretically, even for the whole economy (let alone for regions, groups, and individuals), for a given period, aggregate AOI need not be equal to aggregate TPCP. For the whole economy, aggregate AOI will tend to exceed aggregate TPCP for several reasons: (1) because our data exclude private capital-account activity, by the amount of real investment expenditure in the private sector [8]; (2) by the net flow of non-LSI funds from the official economy to the private sector (e.g., self-employed vendors' incomes, "socialist" bribes to individuals); (3) by the value of crypto-private sales to the household sector, because these cannot be recognized as such and are therefore not reported by our respondents as part of their TPCP, as explained above. On the other hand, aggregate AOI may fall *short* of aggregate TPCP because both (1) sales of left merchandise by socialist enterprises to the public through private intermediaries (i.e. socialist goods will have been perceived by buyers as private goods), and (2) privately sold goods—so recognized by the buyer-respondents of the survey—may contain a substantial component of legitimately paid-for socialist inputs. Other factors may enter into play as well. It is difficult to tell *a priori* how close the two aggregates, AOI and TPCP, will tend to lie in any given year, but however close or far apart the two aggregates may be for the whole economy, the same need not hold for the average (or aggregate) magnitudes of the two variables in regard to a particular population group, such as our sample, and even less so for a subgroup of such a group, such as any of the sub-

[6] A limited attempt to estimate interregional differences in costs of certain services and in wages of unskilled labor can be found in our earlier paper, Grossman 1985.

[7] The claim of mutual independence is true except for the small fraction of AOI and TPCP which consists of self-produced food and gifts in kind from clients, etc., and of parcels from abroad. Such in-kind magnitudes were valued by the respondents themselves, with the ruble amounts entering both the income and the expenditure side of the consumer's budget.

[8] E.g., private expenditures for the building (but not maintenance and repair) of dwellings, garages, orchards, dachas.

samples listed in the stub of Table 2. Negative differences for some subgroups can be (will be) offset by positive differences for other subgroups, to bring about the actual relationship between the economy-wide aggregates.

It is therefore noteworthy that in Table 2 (columns (1) and (2)) the values of AOI and TPCP, though varying considerably among the groups, tend to fall numerically close together for most individual groups, and except for one group, AA, with TPCP moderately exceeding AOI (col. (3)). It almost looks as though our groups, if not individual families, strive to earn income privately, by hook or by crook, in order to spend it privately (outside official channels)—or, conversely, whatever they earn privately, they make sure to spend privately, too.

This relationship is brought out vividly in the bottom panel of Table 2, where we compare the mean values of AOI and of TPCP for pairs of groups, and find that the difference in AOI is remarkably close to the difference in TPCP.(Thus, comparing SRNAA with North (line 15), we find that AOI for the former exceeds AOI for the latter by 230 r/yr, and TPCP, respectively, by 200 r/yr.) To the extent that private income does not fully cover private expenditure, some of the latter must be covered, as it were, by legitimate socialist income (which, in addition, may be called to cover private real investiment and, of course, saving).

In this regard, two groups in Table 2 warrant attention. First, we note that the richest of all the groups, AA F-W, registers a small excess of AOI over TPCP—though at 77 r. out of over 2,000 r., not very meaningful statistically. Second, and more indicative, is the case of Leningrad pensioners, who, with an AOI of only 195 r/yt, managed to spend privately 497 r/yr, thus financing their *private* purchases to the extent of about two-fifths—302 r/yr—out of LSI. (The 302 r/yr represent almost 29 percent of the pensioners' average LSI per person). The next poorest group, Eastern RSFSR, also cuts considerably into LSI to finance private purchases and payments; namely by 132 r/yr, equivalent to about 11 percent of their average LSI. (Any saving or private (real) investment would be additonal charges on LSI or on past accumulation.) Thus, broadly speaking (Table 2), the poorer the group the more it meets its private expenditure out of its legitimage *socialist* income.

To see if the same pattern also holds *within* each group, we turn to Tables 3 and 4, which present data on the lowest and the highest fifths (arrayed in terms of total personal income (TPI)) for each of four groups: North as a whole; within North—separately, Belorussia-Moldavia-Ukraine and RSFSR-Baltics; and finally—AA F-W. Focusing on the AOI-and-TPCP relationship, we see—indeed—that for each of the groups, TPCP *minus* AOI—the excess of private purchases and payments over private income—is positive for the *lowest* fifth and *negative* for the highest fifth (line 15 in Table 3 and 4). This suggests that the poorest (at least the poorest in our sample) cannot avoid spending considerable portions of their LSI on purchases from and payments to private individuals. Notably, those in the lowest fifth in two of the four groups (which happen both to be located in major private-food surplus areas, Bel-Mol-Ukr. and AA (F-W)), each show, on the average, an excess of TPCP over AOI equivalent to about 30 percent of their respective LSIs. Those

in the highest fifth, on the other hand, have more than enough private income to cover private expenditure. They save—perhaps involuntarily.

It is interesting to note that for those in the *lowest* fifth, the need to "dig into" LSI to cover a part of TPCP can be (notionally) largely attributed to cash expenditure on private food, as the following figures show (r/yr/head):

	TPCP-AOI	Private food "cash" expenditure [9]
North	100	108
Bel-Mol-Ukr	231	247
RSFSR-Baltics	44	68
AA, full working households	214	314

TABLE 5.—RELATIONSHIP OF "ALL OTHER INCOME" (AOI) TO "LEGITIMATE SOCIALIST INCOME" (LSI) BY REGIONS AND CITIES, BROKEN DOWN INTO FIFTHS AS ARRAYED BY LSI. FULL, WORKING FAMILIES ONLY

N (persons per fifth)	Means of LSI and AOI rubles/person/year [1]					mF5 : mF1
	mF1	mF2	mF3	mF4	mF5	
North (321):						
LSI	593	865	1,104	1,431	2,441	4.12
AOI	691	653	515	519	905	1.31
AOI ÷ LSI	1.17	.75	.47	.36	.37	
Bel., Mol, Ukr. (111):						
LSI	617	880	1,104	1,420	2,471	4.00
AOI	774	745	656	616	1,577	2.04
AOI ÷ LSI	1.25	.85	.59	.43	.64	
RSFSR, Baltics (210):						
LSI	581	856	1,104	1,435	2,421	4.17
AOI	702	557	434	485	529	.75
AOI ÷ LSI	1.21	.65	.39	.34	.22	
Moscow (33):						
LSI	636	1,003	1,308	1,765	3,450	5.42
AOI	1,051	447	521	661	1,103	1.05
AOI ÷ LSI	1.65	.48	.40	.37	.32	
Leningrad (58):						
LSI	613	995	1,290	1,563	2,436	3.97
AOI	957	703	280	270	487	.51
AOI ÷ LSI	1.56	.71	.22	.17	.20	
AA (Armenians from Armenia) (112):						
LSI	453	753	988	1,379	2,202	4.86
AOI	2,480	1,549	2,031	2,199	2,067	.83
AOI ÷ LSI	5.47	2.05	2.06	1.59	.94	
SRNAA (97):						
LSI	355	632	798	1,088	1,599	4.51
AOI	923	1,024	475	649	1,359	1.47
AOI ÷ LSI	2.60	1.62	.59	.60	.85	

mF1 = mean of ith fifth.
[1] Ruble values indexed to 1977 (see text).

[9] The figures in this column come from our database but not from the Tables in this paper. "For cash" refers to deduction of self-produced food for own consumption, which is an appreciable component of income/expenditure only in the case of the two AA groups.

C. RELATION OF PRIVATE INCOME TO LEGITIMATE SOCIALIST INCOME

As we have seen, the findings of our emigre survey strongly suggest that one of the better predictors of private income per capita (AOI) is geographic location in terms of region or important city within a region, and, for the South, ethnicity (i.e., whether the family is of indigenous or "northern" origin). However, after location and (in the South) ethnicity have been controlled for, legitimate socialist income (LSI) does *not* seem to be a good predictor. Such correlation runs by group as we have attempted, using both linear and quadratic equations and regressing AOI on both LSI and AOI/LSI, invariably yield low values of R-squared. In other words, within a given group (region, ethnic group), the level of a household's legitimate socialist income is not strongly associated with a particular level of private income (and, therefore, also not with a certain level of private expenditure).

Nonetheless, it is of some interest to examine Table 5, in which, for each group, per capita incomes are broken down into fifths *arrayed by LSI.* (Note that in Tables 3 and 4 the division into fifths derives from arraying by *total* personal income per capita (TPI)). The resulting patterns in the individual groups are: (a) The five means of the absolute values of AOI assume a rough U shape (except in the case of AA, where the pattern is rather flat). Thus, in the case of Moscow, the means of AOIs by fifths, reading from the lowest to the highest fifth, are 1,051, 477, 521, 661, and 1,103 r/yr. (b) Accordingly, the corresponding ratios of AOI to LSI by fifths first drop sharply and then decline gradually or flatten out. Thus, in the case of Leningrad, the ratios read: 1.56, 0.71, 0.22, 0.17, 0.20. It would seem, therefore, that *within* our individual groups private income tends to reduce the inequality of distribution of LSI. However, this need not hold *among* groups.

Moreover, it is likely that compared to the parent population, our sample may contain relatively few cases of low AOI associated with low LSIs (e.g., because of underrepresentation of the Eastern RSFSR)[10] and of very high AOIs generally, including particularly those associated with high LSIs, because of underrepresentation of the middle and upper levels of the political, administrative, and police bureaucracies and elites, that is, just those strata of Soviet society which benefited from the acquisitive and corrupt climate of the Brezhnev era.

A good deal more work will have to be done on our data before any conclusions can be drawn regarding the effect of private income and a host of other informal factors on income levels and income distribution.

V. Epilogue

Our tentative, partial, and still unreweighted findings refer chiefly to the second half of the 1970s; in other words, to a period immediately preceding the "bad years" of the Soviet economy be-

[10] Only 29 of the 1061 households in our sample (25 of 729 in the North and 4 of 332 in the South) had a per capita total personal income of 66.6 rubles per month or less, this figure being the "prospective" threshold poverty budget as published in 1967 for an unspecified future date by the Soviet sociologists G.S. Sarkisian and N.P. Kuznetsova. Cf. Matthews, 1986, p. 71.

tween 1979 and, say, the accession of Mr. Gorbachev to the First Secretaryship in early 1985. These later years were marked by aggravated physical shortages of both consumer and producer goods, a likely sharp increase in currency issue (see Grossman 1986), marked rises in kolkhoz-market and black-market prices (insofar as known), seeming intensification of economic crime and corruption, at least up to Mr. Brezhnev's death in November 1982, and a number of cognate developments. It can therefore be presumed that over the "bad years" private income and expenditure grew substantially—both absolutely and in relation to legitimate socialist income. The makings of a major social, political, and economic problem were surely there for any leader to see, and for the right leader to attack with both negative and positive measures. We can thus better understand the high attention and resolute concern directed by Mr. Gorbachev towards the widespread corruption and illegality in the Soviet economy, on one hand, and the prospects of harnessing the underlying energies and quest for material gain for productive activity by legal means, on the other.

VI. Appendix

The Berkeley-Duke Questionnaire Survey

The emigre questionnaire survey of household budgets is, so to say, the central empirical pillar of our over-all project on the Second Economy of the USSR. Before launching it, we conducted several dozen non-questionnaire ("open ended") interviews with well-informed Soviet emigrants (former defense lawyers, prosecutors, judges, underground businessmen, police officials, journalists, etc.), to help design the questionnaire and the sample. We were also encouraged and inspired by the early signs of success of a similar questionnaire survey among Soviet emigrants in Israel conducted by Professors Gur Ofer (Jerusalem) and Aron Vinokur (Haifa). Their survey, however, is not as much pointed toward the second economy as ours. It is a pleasure to record our gratitude to them for valuable counsel in matters both general and specific, and for generously sharing their questionnaire with us.

TABLE A.—DISTRIBUTION OF HOUSEHOLDS AND PERSONS BY REPUBLIC AND FAMILY TYPE

	Total households	Full, working families (F–W)	Pensioner families	Families of single woman and child(ren)	Single women	Single men	Total persons
Northern republics	(729)	(525)	(83)	(43)	(28)	(50)	(1,947)
R.S.F.S.R.	[1] 448	[1] 246	82	42	28	50	1,060
Leningrad	(303)	(103)	(81)	(42)	(28)	(49)	(622)
Other cities	(145)	(143)	(1)	.....	.....	(1)	(438)
Ukraine	119	119	.....	.....	.....	.....	361
Belorussia	37	36	1	.....	.....	.....	110
Moldavia	28	28	.....	.....	.....	.....	89
Latvia	[2] 44	44	.....	.....	.....	.....	131
Lithuania	53	52	.....	1	.....	.....	196
Southern republics	(332)	(316)	(15)	(0)	(0)	(1)	(1,076)
Georgia	46	46	.....	.....	.....	.....	167
Azerbaidzhan	38	38	.....	.....	.....	.....	130
Armenia	211	195	15	.....	.....	1	658
Armenian	(191)	(175)	(15)	.....	.....	(1)	(591)
Non-Armenian	(20)	(20)	.....	.....	.....	.....	(67)
Uzbekistan	[3] 37	37	.....	.....	.....	.....	121
Total households	1,061	841	98	43	28	51	.....
Total persons	3,023	2,657	198	89	28	51	3,023

[1] Includes 1 household from northern Kazakhstan
[2] Includes 2 households form Estonia
[3] Includes 4 households from sourthern Kazakhstan

The unit of observation of our survey is threefold: The household (usually, family)—for most variables, the individual income-earner within the household—for personal income, and every adult in the household, regardless of past income earning, for "perceptions" of side-incomes by the public at large. As with the Ofer-Vinokur survey, our sample is limited to the *urban* population; but unlike that survey, ours includes ethnic southerners (Armenians from Armenia), as well as persons from the northern republics of the USSR. Our questionnaire interviews took place in the United States, and the interviewers were also Soviet emigrants.

Recent Soviet emigrants in the United States are, of course, not representative of the "parent" Soviet urban population in a number of important socio-economic respects. By nationality, they are predominantly, though far from exclusively, Jewish or Armenian. Accordingly, we made a determined effort to give additional representation to other nationalities (including mixed Jewish families), and for analogous reasons also to blue-collar as against white-collar income-earners, to less as against more highly educated families, to former residents of cities other than the largest ones (except Leningrad, as explained below), and to those from southern republics.

The sample covers 1,061 households containing 3,023 individuals, of whom 2,299 were adults (by Soviet definition, i.e., 16 years of age or over) in their "last normal years" (LNY) in the USSR (cf. *infra*). A matrix of household types against geographic locations is depicted in Table A. Of the adults, 52.8 percent are Jewish, 22.0 percent are Armenian, and 18.1 percent are Russian, Ukrainian, or Belorussian. (Nationality is here defined as it stood in the internal Soviet passport.) Despite our sampling effort to the contrary, the sample is a relatively highly educated one. Of the adults, as many as 38.5 percent had gone beyond the secondary level, and 33.8 percent completed higher education.

Two geographic locations, Armenia and Leningrad, constitute special case studies within our survey, the two together accounting for half the households in the total sample. The sub-sample from Armenia accounts for 19.9 percent of sample households and 21.8 percent of sample persons. Of the persons, 89.9 percent are ethnic Armenians, which is very close to the actual proportion in the republic's total population, rural as well as urban, recorded in the 1979 census (89.7 percent). Since the ethnic Armenians are the only titular nationality from a southern republic, this group can (not unreasonably) stand in our sample as proxy for Transcaucasia, a region that plays an important and distinctive role in the Soviet second economy.

All the Armenian families came to the United States in the 1970's from Soviet Armenia proper (though there is also a comparatively large Armenian population in the rest of the USSR). Because of Soviet emigration policy, almost every Armenian sample family contains at least one former "repatriant" i.e., one of the over 100,000 who, in the late 1940's, immigrated into Soviet Armenia from abroad, mostly from the Near East and S.E. Europe. However, many repatriants in our sample were very young when they arrived in the USSR and grew to adulthood there. The non-repatriants in the Armenian sample are typically members of the repatriants' later-formed families. For some research purposes, such as attitudinal topics, being a repatriant (or even a member of his/her family) may set a person apart from the bulk of Soviet Armenia's population, but we do not believe this to be a serious problem for our detailed inquiry into family budgets and related matters.

The other special case, Leningrad, accounts for 28.5 percent of the sample households. Here, in addition to the full, working families that are our exclusive object for all other localities (except Armenia), we collected sub-samples of other types of household, namely, single working males, single working females with children, single working females without children, and pensioner families. We hope that the relationships for the relevant variables between these different kinds of households from Leningrad will provide some insights into corresponding relationships in the USSR as a whole.

On the advice of our survey-research consultants we used the "snow-ball" technique of collecting interviews, constrained in the just-mentioned ways, rather than random sampling. To hold down the risk of "sample inbreeding" (our term) in the course of questionnaire collection, we interviewed in a number of American cities and used many interviewers (except for the Armenians, who were all interviewed in the Los Angeles area, where they are highly concentrated.)

The questionnaire consists of two main parts. The first deals with individual *perceptions* of the size of informal ("left") incomes as supplements to the official earnings of 36 occupations, professions, and jobs listed by us in the questionnaire. Respondents were asked to place a mark against each occupation, etc., in one of eight columns representing left-income class intervals, ranging from zero to "over 300" rubles per months. We deliberately included occupations, etc., which we expected to have very low side incomes (e.g., librarian) as well as those where we expected high ones. Our expectations have been generally confirmed by the survey, though there

are a few surprises, such as the very high assessment of side incomes of directors of funeral parlors. Altogether, 2,076 persons answered the "perceptions" part. No use of this part of the questionnaire is made in the present paper.

The remaining and larger part of the questionnaire pertains mainly to the composition and demographics of the household and to its expenditure, income, and wealth in the "last normal year" (LNY) is the USSR. LNY is defined as the last calendar year in which the household's material circumstances were not yet significantly affected by the prospect of emigration; it is not necessarily a *typical* year in the family's experience.

In regard to expenditures, the questionnaire asks for considerable detail about payments to private individuals for goods and services purchased, for repairs performed, tips and bribes given, rentals paid, and so forth. These data allow us to estimate—albeit approximately—the dependence of the urban population on private sources of supply of goods and services; cf. TPCP in Tables 2-4 above. At a further remove, the expenditure data should help throw some light on the aggregatae hidden incomes of private producers and traders who sell to the urban sector, including those outside the direct purview of our survey, such as agricultural producers, and more broadly to help cross-check our private income data.

In regard to private expenditures, a serious problem of estimation is created by incomes from "crypto-private" production, that is, private activity that hides behind the facade of a socialist enterprise. Such incomes are many and can be quite large individually, but are not likely to be reported by our respondents as payments to private persons, as explained above (Section III) and in Grossman, 1979.

Still in regard to household expenditures, the questionnaire dwells on a number of special problems, such as privately owned housing and related matters; private automobile ownership and outlay on repair, gasoline supply, etc., alcohol purchase, consumption, and use, including illegal home distillation and the use of vodka as a means of payment and of incentive. It also inquires into methods of circumventing goods shortages that were practiced by our respondents (such as exploiting personal connections, paying under the counter, traveling some distance to obtain goods, using "closed distributors"). The questionnaire also seeks data on current saving during LNY, and on stocks of liquid savings and other property at the end of LNY, broken down by major items.

In the income and work sections of the questionnaire, emphasis is placed on second-economy components of income and on time utilization. As noted, this information is sought both of the household as a unit and of each individual member of the household who had significant income during LNY from whatever source. 1,900 persons in our sample had individual income formal/legal and/or informal/illegal.

While the emigrants constitute a far-from-representative sample of the total Soviet population, yet, with the help of purposive sampling and proper re-weighting, one may be able to approximate the general Soviet population in significant respects.

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III. INDUSTRIAL MODERNIZATION

OVERVIEW

By Paul R. Gregory*

Gorbachev's Industrial Objectives

Does Gorbachev's penchant for bold actions in the domestic and international political arena extend to the industrial arena as well? Does Gorbachev's industrial program which he has had more than two years to formulate—offer new solutions to the problems that have plagued Soviet industry for decades? The objectives of the Gorbachev industrial program are spelled out in the Kushnirsky and Leggett papers: Gorbachev's top industrial priority is clearly industrial modernization—to raise the technological level of Soviet industry to that of Western Europe and the United States by the 1990's. Modernization is to be achieved by combining more highly motivated industrial workers, managers, and R&D personnel with modern industrial equipment. The 1986–90 five-year plan initiates Gorbachev's plan for economic revitalization. It aims for annual growth of industry in the 3.5- to 4-percent range, and this growth is to be achieved through increases in labor productivity and material and fuel savings. The economic revitalization plan is supposed to propel the economy into a higher growth trajectory of more than 5 percent per annum by the late 1980's through the 1990's. The industrial modernization program is to be "home grown." The domestic machine-building and metal-working industry, rather than foreign suppliers, is to produce the state-of-art equipment required for modernization, and the shift of resources to machine building will be managed by deemphasizing new construction (emphasizing renovation of existing facilities) and by more economic use of fuels and materials. Another source of reserves for this operation may be a shift of resources from military to civilian use, although this appears less clear.

Feasibility

Each paper in this section poses the question: Are the industrial modernization targets of the 1986–90 five-year plan feasible? The general papers (Kushnirsky, Leggett) ask this question for the industrial sector as a whole, while the industry-specific papers (Braithwaite, Pedersen, Sagers and Shabad, Harris) ask for the specific industry. Each study offers the same answer, albeit from dif-

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ferent perspectives: The industrial modernization plan is not feasible, even for industries that are singled out for high priority. The more general the focus, the more the author focuses on systemic effects, such as incentives, the price system, problems of cross-ministerial coordination, and resistance to innovation. The authors of the industry studies view the reasons for impending failure from a narrower perspective. They add up the resources available to meet the modernization targets, and they conclude that necessary cost economies and productivity improvements will not be forthcoming to meet the targets with available resources.

As Hanson notes in his commentary, pessimism concerning the feasibility of Gorbachev's industrial modernization program is widely shared by experts who have examined this question. This pessimism rests on two grounds. The first is that the 1986–90 industrial plan is technically infeasible. Interindustry bottlenecks will develop that will prevent Gorbachev's industrial growth rates from being achieved. The second source of pessimism is that Gorbachev's economic reforms will not solve long standing wastage and productivity problems. Without resolution of these systemic problems, the economies required to meet the growth targets from projected resources will not materialize.

The papers make clear the ingrained problems that must be alleviated to achieve the goals of the industrial program. A listing of these problems provides an understanding of the magnitude of the problems that must be overcome.

1. An improved incentive system is required to reward the achievement of assortment targets. The Gorbachev modernization program requires extensive renovation of existing production facilities. Renovation requires more custom building of machinery in place of serial production. The lesser reliance on foreign turnkey projects requires the engineering of unique equipment. It requires that the steel industry, for example, produce high-quality precision steel and specialty plates in place of the mass production heavy steels it favored in the past. The current incentive system rewards serial production of homogeneous equipment and materials according to number or weight. Machine builders will be reluctant to sacrifice quantity for the low-run special engineering required to meet the modernization targets. The same is true of the steel industry and industrial plastics.

2. Managerial resistance to new technology must be overcome. Under the Soviet reward system, managers have feared new technologies because of the time needed to install new equipment, to train workers on the new technology, and to correct defects. For the Gorbachev modernization program to succeed, managers must be willing to take on the higher risks that accompany new technologies.

3. Preferences for new construction must be overcome. The Soviet construction industry and its customers have traditionally favored new construction over renovation of existing facilities. The political and economic pressures for new construction are not fully understood, but new construction appears to open the door to multi-year funding; it is favored by regional party officials; renovation requires more custom work; and new construction is more suited to mass production procedures. The implementation of the

Gorbachev program requires that grassroots opposition to renovation be weakened.

4. Enterprises must be encouraged to retire capital on a rational basis. Production target pressures and the desire to rely on tried-and-true machinery have traditionally prevented Soviet enterprises from retiring outdated equipment on a timely basis. For Gorbachev's modernization program to succeed, Soviet enterprises must have an interest in rationally retiring old equipment.

5. Product quality must be accurately assessed and rewarded. With Gorbachev's increasing emphasis on product quality, Soviet planners must be able to assess quality and to reward high quality work and punish low quality work. Past experience has taught that quality assessments cannot rest with the ministries or with the enterprises and that quality standards are readily devalued in a seller's market.

6. Scientific and technical personnel must be rewarded for successful R&D work. Soviet R&D activities are typically carried out in institutes attached to ministries and state committees that are separate from the enterprises that ultimately use the technology. The decision to produce the technology required for modernization at home requires improved work by the R&D establishment.

Gorbachev's Solutions?

Successful implementation of the industrial modernization program requires that each of the above problems be addressed. They are not new problems; most of them have been evident since the early 1930s. The fact that they are known and yet no solution has been found suggests that the solution is elusive. A number of Soviet leaders have sought solutions—Khrushchev, Kosygin, Andropov (briefly), and Gorbachev. How does Gorbachev propose to resolve these longstanding problems of the Soviet planning system?

The papers in this section underscore the traditional and conservative nature of the solutions preferred by Gorbachev so far. Gorbachev offers the traditional mixture of administrative shuffling, personnel changes, campaigns, and incentive-tinkering used by his predecessors. Although the modernization program requires a more flexible and finely-calibrated price system, no fundamental change of the price system is envisioned. In an economy that is driven by renovation, custom engineering, and technological innovation, the price system must be able to differentiate on an increasingly sophisticated basis. The Gorbachev reforms do not appear to move in the direction of loosening the price-system restraints on technological innovation described by Berliner. [1]

Gorbachev resorts to traditional measures in search of sources of improvement. First, he has moved to place vigorous, more critical figures in top ministerial positions. A number of ministers have been fired, and powerful research organizations that have been judged to perform poorly have been closed. Hanson, in his commentary, draws parallels between corporate raiding of inefficiently run corporations in the West and Gorbachev's house cleaning. Given the systemic problems confronting Soviet ministers, it is unlikely that Gorbachev's Soviet-style corporate raiding will make much of a long term difference. Second, Gorbachev is counting on improvements in worker discipline to yield significant productivity im-

provements. His discipline program coincides with an anti-corruption campaign that is also aimed at restoring morale. It would seem that such a discipline campaign would yield, at best, one-time productivity improvements, whereas the modernization program envisions continuous productivity improvements over more than a decade. The success of the modernization program rests heavily on morale factors. Yet, at best, morale factors will yield one-shot returns. Third, Gorbachev is pursuing a "campaign" strategy similar to that used by Khrushchev. Specific industries and activities are being singled out for development such as industrial plastics, robotics, and machine tools at the expense of other activities. The authors of the industry studies emphasize the interrelated nature of modern economies and point out how the non-campaign sectors act as bottlenecks for the campaign sectors. Moreover, previous campaigns have demonstrated the resiliency of branches that have powerful political supporters. Fourth, Gorbachev, like his predecessors, has decided to manipulate enterprise success indicators in the traditional manner described by Kushnirsky. [2] Industrial modernization places greater emphasis on material usage targets, accelerating the retirement of outdated equipment, and meeting assortment targets. Accordingly, these activities will be accorded more weight in the enterprise reward formula. As predicted by Kushnirsky, the elevation of a new success criterion (such as meeting equipment retirement targets) means that entirely new perverse effects will be introduced. One is that managers will scrap perfectly good equipment simply to meet retirement goals. Material economy targets will be met at the sacrifice of some other target. Fifth, Gorbachev has resorted to the traditional tinkering with the administrative structure. The modernization plan calls for the creation of superorganizations that centralize R&D work from basic research to the factory. Interministerial coordination agencies are to be created to handle issues that transcend ministerial boundaries. Administrative tinkering is a time-honored remedy to Soviet economic problems. It is doubtful that Gorbachev's tinkering will yield more substantive results than his predecessors'.

Is There Anything New?

Although Gorbachev appears to favor traditional remedies, there are several new and interesting ideas. First, administrative and R&D personnel are to be paid incentive wages according to their contribution to the modernization effort. Previously, such persons were paid fixed wages according to bureaucratic pay schedules. The notion of incentive wages for administrative and scientific and technical personnel in the R&D establishment is interesting, but it remains to be seen how performance will be judged in an activity as subjective as R&D. Second, a system of external quality control is to be put in place much like that used by the military. Independent auditors (the civilian equivalent of the *voenpred*, or military representative) are to certify products as ready for acceptance. Third, enterprises are to pay for product defects out of their own material incentive fund.

Likely Outcomes

I agree with the general conclusion of the papers on industrial policy that the Gorbachev plan for industrial modernization will not be successful if it proceeds on its current course. Its success requires sustained autonomous improvements in worker morale, whereas such improvements (if they come about at all) should yield one-shot gains. The program does not call for fundamental changes in the price system, whereas more flexible prices are essential if quality production and the acceptance of new technologies are to be encouraged. Soviet-style corporate raiding via replacement of aging ministers with younger and more vigorous technocrats may yield some efficiency gains, but the efforts of skilled technocrats are likely to be thwarted by the systemic inefficiencies they have to face on a daily basis. The forcing of advanced technology on enterprises from above (via a more centralized R&D establishment) is not a new idea. This is the way R&D decisions have been in the past. It simply means that R&D decisions will be made at even higher levels in the planning structure. The setting of capital retirement targets is likely to have the perverse effect of encouraging managers to scrap perfectly good and reliable equipment for untested equipment simply to meet retirement targets. The effort to increase material incentives in the R&D establishment could have positive effects, but it will be difficult to devise a rational incentive system. It is likely, for example, that any R&D incentive system would be tied to material production and would thus downgrade basic research. Efforts to reward product quality by making workers pay for poor quality products out of incentive funds and by using outside auditors are likely to be thwarted by the general seller's market. Gorbachev will likely find it hard to overcome bureaucratic resistance to new ways of doing things. Traditionally, there have been strong forces within the system that favor new construction over renovation. In addition, there has been strong opposition to major shifts in resource allocations. One would imagine that reduction of the military share of machine-building resources would be met with opposition from a number of sides.

NOTES

1. Joseph Berliner, *The Innovation Decision in Soviet Industry*, (Cambridge, Mass.: MIT Press, 1976).

2. F.I. Kushnirsky, *Soviet Economic Planning 1965–1980*, (Boulder, Colorado: Westview Press, 1982).

SOVIET INVESTMENT POLICY: THE KEY TO GORBACHEV'S PROGRAM FOR REVITALIZING THE SOVIET ECONOMY

By Robert E. Leggett*

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SUMMARY

General Secretary Gorbachev has put together a program to modernize the Soviet economy and provide a foundation for higher rates of economic growth in the future. The cornerstone of this program are his investment policies: higher rates of investment spending are planned; heavy emphasis is being placed on the reequipment of existing enterprises; the quality of new investment goods is to be raised by refurbishing the machinebuilding sector of industry, reorganizing the construction industry, and by "administering" a higher rate of technological progress and innovation; and, the distribution of investment has been changed to favor, in particular, the industries that produce machinery and equipment.

Whether Gorbachev's investment plans will succeed where past policies have failed is an open question. The changes Gorbachev is making should provide some boost in growth in the years ahead. It is doubtful, however, that the economy will achieve the level of performance the Kremlin is seeking. A lack of consistency and balance in the regime's program is likely to limit investment growth and cripple Gorbachev's plan for modernizing the economy. The machine building industries, in particular, are unlikely to sustain the high rates of production and achieve the improvements in product quality needed to renovate enterprises and boost the rate of technological change on the scale that Gorbachev has called for. In

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addition, the perverse nature of the Soviet incentive and planning system will work to blunt the effectiveness of the new investment policies.

If Gorbachev's program comes up short, as is likely, the Soviets could face more difficult problems in the future. The crunchpoint could come as early as the late 1980's when all the major claimants on Soviet output are likely to be in need of and demanding a greater share of the GNP pie.

I. Introduction

Almost from the day Mikhail Gorbachev became General-Secretary of the CPSU in March 1985, he proclaimed that his first priority would be the revitalization of the Soviet economy. When he assumed power, economic growth was sluggish; it had been trending downward for several decades. Moreover, the Soviet Union had been left out of the technological revolution that had benefited the West since the early 1970's. As a result, the technological gap between East and West was widening.

The new regime has moved very rapidly to get the Soviet economy moving again. Gorbachev has instituted or expanded policies to increase worker discipline, to reduce corruption, and to eliminate alcohol abuse. He has made sweeping personnel changes, bringing in a cadre of technically competent officials with better leadership skills. In addition, major areas of the economy have been or are in the process of being reorganized.

But, most important, he has put together a program to modernize the Soviet economy across the board and provide a foundation for higher rates of economic growth in the future. The cornerstone of this program is an investment strategy that calls for higher rates of investment spending, heavy emphasis on renovating existing production facilities, and an allocation policy that heavily favors selected, key industrial sectors. This article describes and analyzes Gorbachev's investment policy and assesses the likelihood of its success.

II. Background—Postwar Investment Policies

Soviet investment policies have varied substantially during the postwar period. During the decade of the 1960's and into the early 1970's, Soviet planners relentlessly pushed the expansion of capital assets by allocating a large and rising share of resources to capital investment, holding retirement rates to a minimum, and prolonging the service lives of technologically obsolete plant and equipment through repeated major repairs. Between 1960 and 1975, for example, total investment increased about 7 percent annually. In addition, the bulk of new fixed investment was channeled into new construction projects and the expansion of existing facilities.

1976-80 plan.—In the mid-1970's, the investment strategy shifted to reflect the leadership's attempt at "intensive" development of the economy—that is, reliance on more efficient use of resources and on more rapid technological progress for economic growth. The leadership markedly slowed the rate of increase of new fixed capital investment. Growth of investment was cut to less than half the average rate of increase achieved during the Ninth Five-Year Plan

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period (1971–75). The slowdown in investment growth was predicated on the assumption that growth in GNP could be sustained by increases in capital (and labor) productivity. At the same time, Soviet planning officials began to emphasize the modernization of existing production facilities rather than the expansion of capital assets. Indeed, increases in productivity during 1976–80 were planned to come primarily from renovation and modernization.[1] New construction was to be markedly reduced.

As events turned out, the Soviets were successful in slowing the growth of new fixed investment to about the rate planned. The construction component of investment, moreover, slowed markedly; it grew less than 1 percent a year on an average annual basis compared to almost 6 percent a year during 1971–75.

1981–85 plan.—Soviet planners continued the "intensive" approach to development in the 11th Five-Year Plan. The growth of total new fixed investment was slashed further. In the original 1981–85 Plan, total new fixed investment was scheduled to increase by 12–15 percent in the five-year period compared to the last half of the seventies. This goal was reduced even further—to 10.4 percent—by General-Secretary Brezhnev at the November 1981 meeting of the Supreme Soviet. The principal theme of the investment policy continued to be increased emphasis on renovating and reequipping existing facilities on the assumption that it is less expensive, promotes more rapid technological change, and shortens construction time.

The 1981–85 Plan apparently triggered a heated debate in the Soviet Union over the regime's investment policies. Prominent Soviet economists such as Abel Aganbegyan and K.K. Val'tukh argued in the open press that increased capital productivity and the success of an intensive development strategy, at that junction in Soviet development at least, require increased, not reduced, growth in investment. They also maintained that the planned distribution of investment goods was unbalanced. Aganbegyan, in particular, argued strenuously for more investment in the machinery sector since, in his words, in the long run the production capacity of other industries depends on the acquisition of more and better machinery. Other economists, such as D. Chernikov of the Gosplan Economics Institute, countered that the complementarity of capital and labor required the rate of growth of investment to be slowed in order to be consistent with the slower growth of the labor force and to allow for lags in the assimilation of new capital assets.[2]

The Aganbegyan faction apparently won out very early in the 11th Five-Year Plan period. Total gross fixed capital investment increased more than 17 percent during 1981–85 compared to the 10.4 percent rate planned. (It increased 3.5 percent on an average annual basis compared to a planned rate of under 2 percent).

The plan for the distribution of investment resources was changed as well (see Table 1). Actual investment in the machine-

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[1] The Soviets have long emphasized the reconstruction of existing production facilities. Stalin, for example, singled out this strategy in his speech to the 17th CPSU Congress in 1934.

[2] For a further discussion of this debate see Robert E. Leggett, "Soviet Investment Policy in the 12th Five-Year Plan". *Soviet Economy in the 1980s: Problems and Prospects*, Part 1, Joint Economic Committee, Congress of the United States, 97th Congress, 2nd Session, 31 December 1982, pp. 129–146.

building sector of industry, for instance, grew faster than total investment, and about twice the originally planned rate. On the other hand, the increase alloted to the fuel and energy complex, while very large—45 percent—was less than planned. The actual growth in investment in the oil industry, however, exceeded the plan, coal was about on target, but gas allocations appear to have been cut substantially. A major surprise was the very low increase in investment growth in the ferrous metals industry which may be one of the reasons this key sector performed so poorly during 1981–85. It is worth noting that investment in the rest of industry rose a paltry 3 percent during 1981–85 compared with 1976–80.

TABLE 1.—USSR: INVESTMENT IN THE 11TH FIVE-YEAR PLAN

[Billion rubles—1984 prices]

	1976–80 actual [2]	1981–85 actual [2]	Percentage increase planned 1981–85 over 1976–80 [1]	Actual increase 1981–85 over 1976–80
Total investment	717.7	792.3	843.2	10.4	17.5
Industry	251.4	309.0	300.7	23	20
Ferrous metals	17.1	22.2	17.9	30	5
Fuels and power	74.9	113.8	108.4	52	45
Oil	29.3	48.0	50.3	63	72
Coal	11.4	13.7	13.5	20	18
Gas	11.3	22.0	15.9	95	41
MBMW	60.9	67.0	73.0	10	20
Other	98.5	106	101.4	.....	3
Agriculture	143.2	153.2	156.2	7	9
Agriculture—whole complex of works	193.9	215.2	222.3	11	15
Transportation and communications	85.0	NA	104.3	.....	23
Railroads	20.1	24.5	24.1	22	20
Construction	28.1	NA	30.4	NA	8
Housing	101.9	110.1	127.7	8	25

[1] See Robert E. Leggett, "Soviet Investment Policy in the 11th Five-Year Plan", Soviet Economy in the 1980s: Problems and Prospects, Part 1, Joint Economic Commitee, Congress of the United States, 97th Congress, 2nd Session, December 31, 1982, pp. 129–146.
[2] N. kh. 1985, pp. 366–368.

III. Gorbachev's Economic Program

Gorbachev moved quickly in his first year in office to put together a long term plan for economic recovery (see figure 1). His goal is to raise the technological level in the USSR to that of the leading Western economies by the end of the decade. As part of this effort, the Soviets intend to enter the decade of the 1990s having replaced about one-third of the economy's stock of machinery and equipment and no less than 35 percent of the total industrial capital stock.[3]

[3] *Pravda*, 3 July 1986, p. 1.

FIGURE 1.—GORBACHEV'S PLAN FOR ECONOMIC REVITALIZATION—1986–90

Stage I (mid-1980's)	Stage II (late 1980's)	Decade of the 1990's Stage III
1. Human factors: —increase worker discipline —anti-corruption campaign —anti-alcohol campaign —increased worker incentives —organizational changes	1. General modernization—renovate existing facilities	Synergistic effect of Stage I and II policies propel economy onto a higher plane of growth
2. Lay groundwork for modernization: —crash retooling of MBMW —restructure construction sector —reorganize investment to focus on increasing capacity for producing high technology products (robots, telecommunications, electronics, computers)	2. S&T revolution—emphasis on hi-tech industries.	
3. Resource savings: —substitute capital for labor in low technology functions —stringent fuel and raw material standards	3. Better trained work force: —education reform —more vocational training —better management techniques	

GOALS FOR GROWTH

3.5–4.0 annual growth	More than 5 percent annual growth
Sources of growth: (1) Increases in labor productivity: ⅓ from human factors ⅔ from modernization. (2) Resource savings	Sources of growth: (1) Increases in labor and capital productivity (2) Resource savings—70–80 percent of fuels and materials increment

Much of Moscow's manufacturing base is obsolete and needs to be refurbished. An article in the 13 June edition of "Leningradskiy Rabochiy" provides an illuminating example of the age structure of Soviet capital assets. The article examines the condition of a hydor-mechanical equipment factory's machine capacity. According to the article, about 12 percent of the plant's capacity is under five years old, approximately 2 percent is between 6 and 10 years old, 20 percent is between 11–15 years old, and over 66 percent is at least 16 years old—including some as old as 30–40 years. One Soviet author estimates that 30 to 40 percent of equipment in operation in the USSR has been in use for 15 to 20 years or more.[4]

Chairman Ryzhkov announced at a meeting of the Supreme Soviet in June 1986 that retirement rates would be raised during the 12th Five-Year Plan period. Retirement rates for capital assets historically have been extremely low in the USSR (see table 2).[5]

[4] M.S. Zotov, "Intensifikatsiya Investitsionnoyo protess", *Voprosy ekonomiki*, February 1984, p. 11.

[5] Soviet retirement rates are low relative to those in Western countries. According to data computed by Stanley Cohn, the rate at which machinery and equipment is retired in USSR is anywhere from one-half to one-third such rates in major Western countries. The rate at which nonresidential structures are actually retired ranges from two-thirds to one-quarter the retire-

TABLE 2.—RETIREMENT RATES OF THE SOVIET CAPITAL STOCK

[Percent]

	Industry			Economy wide
	Total	Buildings and structures	Machinery and equipment	Total
1975	1.6	0.8	2.4	NA
1980	1.4	.5	2.5	2.6
1981	1.3	.5	2.3	2.2
1982	1.2	.4	2.2	2.1
1983	1.3	.4	2.3	2.1
1984	1.3	.4	2.3	2.1
1985	1.4	.4	2.5	2.1

Source: "Narodnoye khozyaystvo", various issues.

Notes.—See Martin J. Kohn and Robert E. Leggett, "A Look at Soviet Retirement Statistics: Unraveling Some Mysteries?", "Comparative Economic Studies", (summer, 1986), pp. 21-35, for a discussion of Soviet retirement rates.

Enterprises hold onto captial assets for excessively long periods, preferring to keep equipment functional through major capital repairs. The costs of such repairs have become staggering. According to one Soviet analyst, outlays for the capital repair of machines and equipment in industry alone amounted to approximately 42-43 billion rubles during 1981-85. (This equates to almost 15 percent of industrial investment during the 11th FYP). Approximately 10-12 percent of industrial workers and more than 27 percent of the park of metalcutting machinetools currently are used to repair machinery and equipment. This same author estimates that capital repair outlays could grow by 40 to 50 percent in the 12th Five-Year Plan Period.[6]

SOVIET PLANNED RETIREMENT RATES FOR 1986-90

[Annual rates in percent]

	1985	1990
Total fixed assets	1.8	3.1
Machinery and equipment	3.2	6.2

A. INVESTMENT POLICY—THE CORNERSTONE OF THE PROGRAM

In his report to the Central Committee in June 1986, Gorbachev castigated past investment policies, blaming them for current economic difficulties in the USSR.

> . . . they (economic difficulties) boil down primarily to serious errors in the policy of capital investments. There was no justification for the reductions of investment increases five year period after five year period. As a result, such basic industries of machinebuilding as machine tool construction, instrument-making, computer technology, and the manufacture of progressive structural materials were not developed properly.[7]

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ment rates occurring in the West. See Stanley H. Cohn, "Sources of Low Productivity in Soviet Capital Investment", Soviet Economic Committee, U.S. Congress, *Soviet Economy in the 1980's: Problems and Prospects* (Washington, DC, 1983) p. 181.

[6] V.V. Muzhitskikh, "Finansirovaniye i kreditovaniye kapital 'nogo stroitel' stva v usloviyakh ekonomicheskogo eksperimenta, Moscow, *Finansy i Statistika*, 1985, pp 130-131.

[7] *Tass*, 16 June 1986.

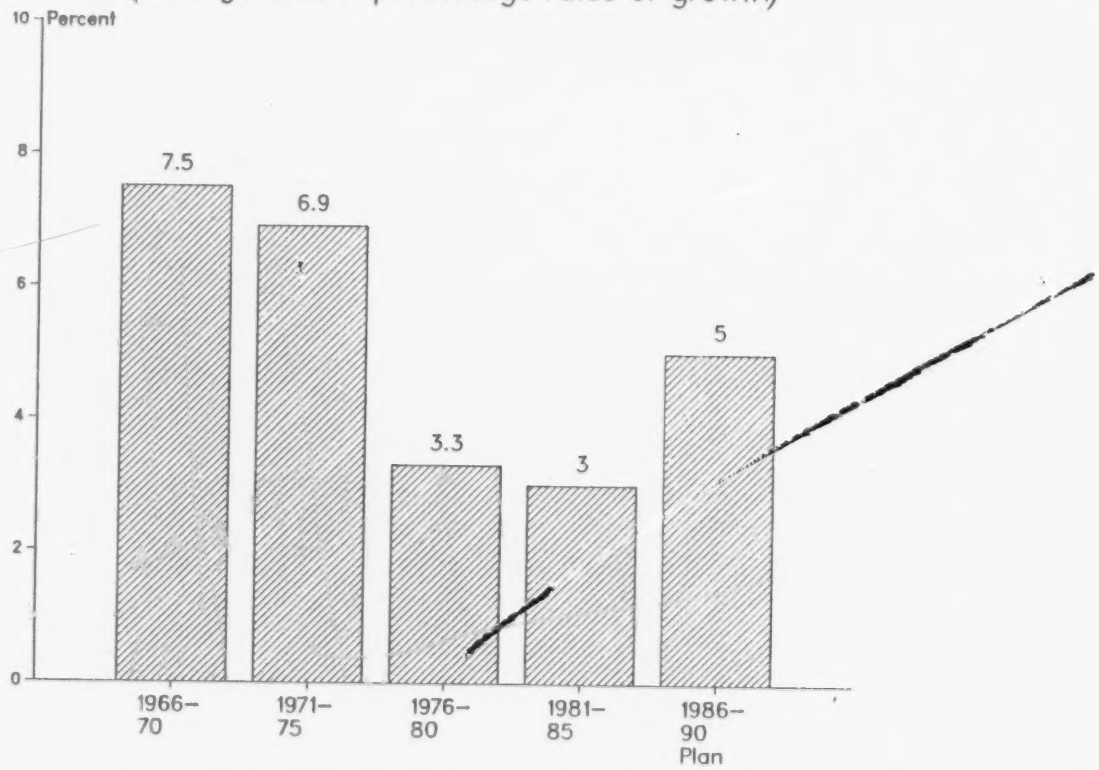
The General Secretary has moved decisively to forge a new investment policy. Indeed, he has made it the cornerstone of his economic program.

1. More investment

The growth of capital investment has been markedly increased (see figure 2). The plan guidelines announced at the 27th Party Congress in February-March 1986 called for investment to rise by 18–22 percent during 1986–90—investment grew by roughly 17.5 percent during the 11th five year plan period. That target already has been revised upward. Chairman Ryzhkov announced to the Supreme Soviet last June that investment would rise 23.6 percent during 1986–90—approximately a 5 percent annual rate of growth compared to about 3.5 percent during 1981–85. The actual rate of increase may end up being even higher—a 7.6 percent rate of growth is planned during 1986 alone.[8]

[8] There are indications that Gorbachev may not be satisfied with the 12th Five-Year Plan. He remanded it to Gosplan several times for revision prior to the 27th Party Congress. Three drafts were reported to have been rejected as underambitious. A fourth draft was finally approved and published in the form of the "basic guidelines" in November 1985. The final draft was approved by the Supreme Soviet and published on 20 June 1986.

Figure 2
USSR: Growth of Fixed Capital Investment
(Average annual percentage rates of growth)



2. Restructuring investment

The distribution of investment, both between new construction and renovation and among sectors of the economy has been changed. New construction is to be markedly curtailed, particularly in the European USSR; spending is to be concentrated instead on renovating existing facilities. Equipment in current operation is to be replaced as rapidly as possible with new, state-of-the-art machines as the primary means of introducing new technology into the economy. The bulk of this new equipment is to be manufactured at home. The amount of investment resources to be utilized for the renovation of enterprises during 1986–90 is very large. The share of investment allocated for the reconstruction of existing facilities is to rise from 37 percent of total state "productive" capital investment in 1985 to 50 percent in 1990 (see Table 3).

TABLE 3.—USSR: STATE CAPITAL INVESTMENT IN RECONSTRUCTION, EXPANSION, AND NEW CONSTRUCTION [1]

(Billion rubles—1984 prices)

	1980	1981	1982	1983	1984	1985	Average annual rate of growth in percent	
							1981–85	1986–90
Reconstruction of existing enterprises	23.8	25.0	26.5	28.6	30.8	33.4		
(Growth rate—in percent)		5.0	6.0	7.9	7.7	8.4	7	[2] 11
Expansion of existing enterprises	20.9	20.6	20.1	21.1	20.7	20.5		
(Growth rate—in percent)		−1.4	−2.5	5.0	3.0	−1.0	−0.4	NA
New construction	27.3	28.8	29.6	31.2	32.3	31.7		
(Growth rate—in percent)		5.5	2.8	5.4	3.5	−2.0	3.0	NA

[1] Values for 1980–1985 are taken from N.kh. 1985, p. 52.
[2] Estimated. Ryzhkov stated in his June 1986 speech to the Supreme Soviet that investment to renovate existing enterprises would total 232 billion rubles in 1986–90. This equates to about an 11 percent average annual rate of growth during this period. The comparable figure for 1981–85 was about 7 percent.

Gorbachev stated in a speech in December 1985 that the long-standing practice of allocating economic branches the same proportion of new investment from one plan to the next would also be "changed decisively". Unfortunately, Moscow has not published enough information to fully analyze the plan for distributing investment resources during 1986–90. Some insights are possible, however, from information that has appeared in the open press (see Table 4).

TABLE 4.—USSR: DISTRIBUTION OF INVESTMENT IN THE 12TH FIVE-YEAR PLAN [1]

Sector	Billion rubles—1984 prices		Percentage increase
	1981–85 (actual)	1986–90 (plan)	plan 1986–90 over 1981–85
Total	843.2	1,042	23.6
Productive	614.8	769	25
Industry	300.7	NA	NA
Fuels and power	108.4	[2] 147	35
Chemicals	22.6	34	50
MBMW	73	[3] 100	37
Agriculture	156.2	165–170	about 7
Agro-industrial complex	269	[4] 343	28
Transportation	[5] 64.5	[5] 67	[5] 4.3

TABLE 4.—USSR: DISTRIBUTION OF INVESTMENT IN THE 12TH FIVE-YEAR PLAN [1]—Continued

Sector	Billion rubles—1984 prices		Percentage increase
	1981–85 (actual)	1986–90 (plan)	plan 1986–90 over 1981–85
Railroads	24.1	[6] 28.2	[6] 17
Communications	[5] 5	[5] 7	[5] 40
Light industry	11.0	13.7	[7] 25
Nonproductive	228.4	273	20

[1] Data for 1981–85 are from Narodnoye khozyaystvo SSSR v 1985. Plans for 1986–1990 were culled from leadership speeches published in the open literature.

[2] The Soviets have stated that 180 billion rubles will be spent on the development of the fuel and energy complex in the 12th FYP—a 35 percent increase over 1981–85. Netting out expenditures on pipelines—estimated at 31 billion rubles—yields an estimate for 1986–90 of about 147 billion rubles.

[3] Estimated. Gorbachev, in a June 1986 speech, stated that the civilian sector of MBMW consumed 5 percent of the total volume of productive investment during 1981–85. This implies about 31 billion rubles was allocated to civilian machinebuilding and about 41 billion rubles for military machinebuilding. The value of total investment for 1986–90 was estimated by assuming an 80 percent growth in the civilian sector and an arbitrary 10 percent growth on the military side.

[4] Estimated as a ⅓ share of total investment.

[5] Estimated and rounded from data appearing in V. Biryukov, "Transportation and Communications in the New Five-Year Plan", Planovoye khozyaystvo, no. 6, June 1986, pp. 17–26.

[6] Pravda, 17 July 1986, p. 1.

[7] Interview with Alexandra Biryukova as reported in Sofia, Robatnicheskodela, Bulgaria, 18 July 1987.

What stands out is the huge commitment of resources Moscow is making to the machinebuilding and energy sectors of industry. The increment in investment targeted for those two sectors alone accounts for about 42 percent of the total increment planned for "productive" investment during 1986–90. The large increase slated for the machinery industries reflects the priority the leadership attaches to the modernization program. These are the industries that produce the modern equipment required to retool and refurbish Moscow's manufacturing facilities. The regime apparently has modified its plans for investment in the energy sector for at least the second time. Ryzhkov had announced in March that a 47 percent increase was planned.[9] The target for investment growth in the fuel and energy complex now stands at 35 percent.

3. Raising the quality of investment

The leadership also is taking steps to try and raise the quality of new investment goods. Gorbachev's economic program calls for a wholesale retooling and the general refurbishment of the machinebuilding industries. These industries have to be retooled if they are to provide the state-of-the-art equipment needed to modernize the economy. The importance attached to this aspect of the regime's program is clear from Ryzhkov's June speech to the Supreme Soviet:

> Without a fundamental improvement in the structure of machinebuilding production and an increase in the technical standard of its output, it will be impossible to solve any of the program tasks facing the country.

Indeed, the regime has moved very boldly in implementing plans for upgrading the civilian machinebuilding industries:

—Investment is to increase by 80 percent during 1986–90 (see Table 5). A huge 30 percent increase is scheduled for 1986 alone.

[9] In a June 1985 address to the special conference on S&T, Gorbachev stated that the share of investment in energy could be stabilized by giving greater attention to conservation. That implied a rate of increase of about 20 percent, the growth planned for total investment at the time.

—Obsolete equipment is being rapidly retired and replaced. A major one time write off of old machinery is planned for 1986. Thereafter the rate of retirement is to rise steadly to about 10 percent in 1990. (It was 2.2 percent in 1985.) During the 12th FYP, the Soviets are planning on replacing about 60 percent of the current stock of machinery and 45 percent of the overall capital stock in MBMW.[10]
—A Bureau of Machinebuilding has been created under the USSR Council of Ministers to coordinate and manage the activities of the eleven civilian machinebuilding industries. The primary task of the Bureau is to raise technical standards in these industries.
—Investment allocations during 1986–90 are to favor high technology sectors such as machine tools, computers, electronics, and instruments.

TABLE 5.—USSR: INVESTMENT IN MBMW

[Billion rubles—1984 prices]

Period	Investment in MBMW	Share of total investment in percent	Share of total industrial investment in percent
1971 to 75	[1] 43.1	7.7	22
1976 to 80	[2] 60.9	8.5	24
1981 to 85	[1] 73	8.7	24
1986 to 90 (plan)	[2] 100	[2] 10	[2] 30

[1] Nkh 1985 p. 368.
[2] Estimated.

A new system of quality control in civilian industry also is being introduced. Responsibility for monitoring the quality of output produced is being taken away from plant managers and internal plant inspectors and given to representatives assigned to the plant by a new organization—the State Acceptance Organization (*Gosudarstvennaya Privemka*) under the State Committee for Standards. The new inspectors are to have the authority to reduce monthly pay and bonuses at enterprises that fail to meet quality standards. In addition, prices are to play a more active role in creating incentives for manufacturing higher quality products. Beginning next year, for instance, products that are 50 percent better than existing analogous products in terms of productivity and reliability will be marked up in price by as much as 30 percent. Meanwhile, a system of progressive price discounts on existing machinery products is to be put in force.

The regime also is taking a hard look at the construction sector. Quoting from Ryzhkov's June speech to the Supreme Soviet:

> Accelerated development of the economy in the 12th FYP and in the longer term can be achieved only if the work of the entire construction complex * * * is radically improved.

The construction industry has been an inefficient and trouble-plagued sector. The quality of construction in the USSR is poor and

[10] V. Kirichenko, "Talks about the Five Year Plan: Plan for a Radical Breakthrough", Pravda, 5 July 1986, p.2; See also editorial titled "Taking Responsibility for Quality", Pravda, 3 July 1986, p.1.

construction time is so long that plants are often obsolete before they are brought on line. According to Stroybank, for instance, 25 percent of the construction projects currently under way in the USSR were begun 10–20 years ago.[11]

Performance in the construction sector has been poor largely because of a lack of proper incentives and the relatively low priority given this sector by Soviet planners in the past. Investment allocations, for example, have been sparse—about four percent of total investment annually during the last decade and a half (see table 6). As a result, construction firms currently are not well equipped to carry out the renovation work called for under the modernization program.

TABLE 6.—USSR: INVESTMENT IN THE CONSTRUCTION SECTOR

[Billion rubles—1984 prices]

Period	Investment in the construction sector [1]	Share of total investment in percent
1971–75	20.6	3.7
1976–80	28.1	3.9
1981–85	30.4	3.6

[1] Nkh. 1985, p. 367.

Gorbachev recently ordered a major reorganization of the construction sector as a first step in trying to improve performance in this sector. A new State Construction Committee was created last August under the Council of Ministers. The new committee has been assigned the task of planning and supervising the work of construction ministries, overseeing an improvement in quality control in the construction sector, and ensuring that construction deadlines are met. A major goal of the Gorbachev program is to cut construction time at least in half during the 12th Five Year Plan period.

The intensive side of Gorbachev's modernization program extends also to the science sector. In short, the Soviet policy is one of "administered" technical progress rather than reliance on the self interest of participants in the R&D process and enterprise managers to develop and assimilate more productive investment goods. In this regard, the Academy of Science is being directed to establish new departments—oriented toward applied research—that will support the development of new machinery and equipment. Twenty interbranch scientific-technical complexes (MNTKS) have also been established with a similar purpose. In addition, within MBMW, a new research and development structure is taking shape. This reorganization is being counted on to help achieve the 1986–90 plan goals of reducing the time needed to renew the product assortment in machine building, raise the technical level of research and design work, and cut the time taken to test and perfect new models.[12]

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[11] M.S. Zotov, *op.cit.*, p. 11.

[12] For a further discussion of Gorbachev's science policy see James Noren, "Soviet Investment Strategy Under Gorbachev's, paper delivered at the 18th National Convention of the American Association for the Advancement of Slavic Studies, 23 November 1986, unpublished, and Paul Cocks, "Soviet Science and Technology Strategy", in this volume.

IV. Will the Investment Plan Work?

A. TESTING FOR CONSISTENCY

The investment plans announced by the Gorbachev regime clearly break with policies of the recent past. Overall investment growth is higher, the share going to the replacement of obsolete assets is greater, and the distribution of investment has been changed. Whether Gorbachev's investment plan can succeed where past policies have failed, however, is an open question.

For the investment program to make sense it must be consistent with other plans and objectives of the regime. One test of the program's consistency is to compare what the share of new equipment in the economy's capital stock will be by 1990, given planned rates of investment growth and planned retirement rates for capital assets, with the regime's stated goal that one-third of the country's stock of machinery and equipment must be new by the end of the decade. Our calculations indicate that meeting this target is almost a routine exercise. Given the higher retirement rates, about 41 percent of the equipment on hand in the total economy at the end of 1990 will have been installed during 1986–90 (see table 7). However, the replacement target could easily be met if the Soviets continue to retire machinery at current low rates. Under this scenario, about 38 percent of the in-place machinery will be new in 1990.

TABLE 7.—SOVIET PLANS FOR THE RETIREMENT OF CAPITAL ASSETS DURING 1986–90 IN THE TOTAL ECONOMY

[Percent]

	Share of new assets in 1990 capital stock		Share of 1985 assets retired	
	At current retirement rates	At planned retirement rates	At current retirement rates	At planned retirement rates
Total capital stock	31	[1] 33	12	24
Buildings and structures	23	[2] 24	10	14
Machinery and equipment	38	[3] 41	18	28

[1] Overall retirement rate prevailing in 1981–85 is assumed to double.
[2] Soviet plans call for the retirement rate of fixed assets to increase from 1.8% in 1985 to 3.2% in 1990. Rates were increased proportionately during the period.
[3] Soviet plans call for the retirement rate of machinery and equipment to increase from 3.2% in 1985 to 6.2% in 1990. Rates were increased proportionately during the period.

A more rigorous test is the consistency of production goals for 1986–90 with the growth in investment planned. To test this proposition, we examined the trends in incremental capital-output ratios (ICORs) in industry—that is, the additional investment associated with a ruble's worth of additional industrial production. The ratios were then used to test the consistency between Soviet industrial output and investment plans for 1986–90.[13]

The analysis was restricted to industry because of the lack of data for other sectors of the economy. Alternative sets of investment requirements were calculated depending on whether (a) the ICORs continue the same long-term trend as during 1961–85 (vari-

[13] For an similar analysis of the 1981–85 Plan, see Robert E. Leggett, "Soviet Investment Policy in the 11th Five-Year Plan", Joint Economic Committee, U.S. Congress, "Soviet Economy in the 1980s: Problems and Prospects" (Washington, DC, 1983), pp. 129–146.

ant I in table 8), (b) the ICORs continue at 1985 levels during 1986–90 (variant II), or (c) the ICORs behave as they did during 1981–85 (variant III).

TABLE 8.—USSR: ESTIMATED INVESTMENT REQUIREMENTS FOR SELECTED INDUSTRIAL SECTORS, 1986–90 [1]

[Billion rubles, 1973 prices]

	Variant I: 1961–85 ICOR trend continues	Variant II: ICOR stays the same as in 1985	Variant III: 1981–85 ICOR trend continues	Planned investment [2]
Fuels	196	138	192	131
Electric power	29	28	23	
Machinery	139	123	110	91
Chemicals	50	44	43	30
Construction materials	57	49	48	[3] 11

[1] The ICORS were derived by dividing changes in the capital stock by changes in output. The figures in the table give investment requirements for each industry on the assumption that investment is equal to the expansion of the capital stock commensurate with various ICOR trends. No allowance is made for replacement of wornout structures and machines as well as for increases in unfinished construction, hence these figures are probably too low. Neither was any additional adjustment made in the case of the fuels sector although expenditures for drilling are classified as new fixed investment but do not result in additional commissioned capacity.

[2] Adjusted data expressed in 1984 prices to a 1973 price base.

[3] 1981–85 data increased 15 percent (see James Noren, "Soviet Investment Strategy Under Gorbachev", op. cit., p. 16) and adjusted to 1973 prices.

The results of the exercise were somewhat surprising. For industry as a whole and for all sectors tested except fuels, the data show that the Soviets managed during the 11th Five-Year Plan period to arrest, and sometimes reverse, the long time, monotonic increase in incremental capital-output ratios. In overall industry, for instance, the turning point apparently occurred around 1981 (see figure 3). Whereas in 1981 each additional ruble worth of output was associated with 9 additional rubles worth of capital, in 1985 about 6 additional rubles worth of capital was required.

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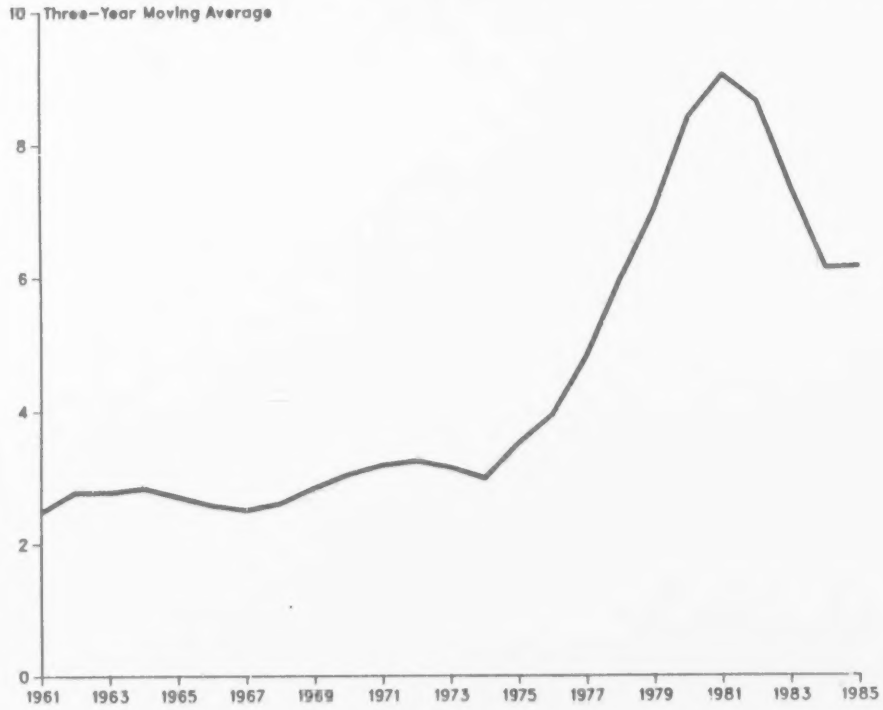
Figure 3
USSR: Increment Capital–Output Ratios in Industry, 1961–85



Almost all the ICORs for individual industrial sectors exhibited the same trends as industry as whole. That is, the ICORs peaked in the early 1980s and have been constant or falling slowly ever since. Only in the fuels sectors did the incremental amount of capital required to produce an additional rubles worth of fuel continue to increase. Whereas in 1975 this ratio was about 5, in 1980 it was close to 20, and had skyrocketed to over 40 in 1985. This is not surprising, of course, given the rapidly escalating costs of exploring, drilling, and processing oil, gas, and coal in the Soviet Union.

Based on the information available for a limited number of industrial sectors, it appears that, despite recent improvements in the ICORs, the output targets generally are high relative to projected capital outlays. This is especially true if recent ICOR trends stabilize or reverse themselves. In the fuels sector, of course, investment needs have gone through the ceiling and will far outstrip planned allocations. It appears, therefore, that significant increases in capital productivity will be needed in most sectors to meet the 1986–90 output targets.[14]

The demand for producer durables under Gorbachev's modernization program also should be consistent with the planned supply of machinery and equipment during 1986–90. Borrowing Professor Robert Campbell's notion of a kind of "Okun's Law"—that is, a 1 percentage point rise in the share of renovation and reconstruction in "productive" state investment corresponds with a one-third of a percentage point rise in the share of machinery in total capital investment—it should be possible to estimate Moscow's equipment needs during 1986–90 given that the share of renovation spending in total state "productive" investment is planned to increase from 37 percent in 1985 to 50 percent in 1990. Adjusting for the portion of machinery that is imported—perhaps 30 percent from Communist countries and another 10 percent from the West—and assuming little growth in Western imports but perhaps a 2.5 percent annual growth in machinery imports from Communist countries, domestic production of producer durables would have to rise by about 11 percent a year during 1986–90 to meet the needs of the modernization program. Such a high rate of output growth is almost certainly beyond the capability of these industries during 1986–90.

B. TESTING FOR BALANCE

Although information is sparse, the 1986–90 Plan for the distribution of investment does not appear balanced. Within industry, for instance, the large growth in investment planned for the fuels industries, chemicals, and the machinebuilding sector will leave little room for increases in other industries which feed into the production of investment goods. Some sectors may, in fact, have to be cut. Ferrous metallurgy, for example, is a key sector of industry and will play a vital role in the modernization effort; about 80 per-

[14] Some Soviet officials openly recognize the difficulty of meeting the 1986–90 plans. A recent article in a Soviet newspaper stated that capital investment would have to increase 30–40 percent—a 23.6 percent growth is planned—and an additional 8–10 million workers would be necessary—the labor force will expand by about 4 million persons—to achieve the 12th FYP goals. See Ekonomicheskaya gazeta, No. 47, November 1985, p. 2.

cent of all external deliveries from this sector go to machinebuilding industries. It is badly in need of modernization and will require large amounts of investment resources to make up for the low priority afforded it during 1981–85. Given the large commitment to other sectors, however, it appears that ferrous metals may come up short again. If so, production shortfalls in metallurgy are likely to be a major constraint on domestic machinery production during 1986–90. The same is true of the construction materials industry which is a major supplier of the construction industry. If bottlenecks arise, they could impede construction activity and delay the modernization of production facilities.

C. OTHER PROBLEMS

Other potentially serious problems stand in the way of Gorbachev's investment program as well. Perhaps the most serious is the Soviet incentive system which causes plant managers to resist shutting down production lines for modernization rather than risk not meeting output targets. It also has an adverse impact on the performance of the so-called investment complex—the centers that design construction projects, the enterprises that do the construction work, and the firms that produce machinery and equipment.[15] Without an extensive restructuring of the incentive system, which does not appear in the works, Gorbachev will be hard pressed to force renovation onto a reluctant cadre of workers and managers.

Soviet plans call for MBMW to be modernized almost overnight. The success of the 1986–90 investment strategy, in fact, depends very heavily on the performance of the machinebuilding industries. But modernization takes time. New technology has to be designed and produced, production lines have to be shut down for renovation, and work forces have to be retrained. In Boris Rumer's view, "The campaign to accelerate the production of 'revolutionary technology' in machinebuilding has resulted in the diversion of enormous resources without regard to economic and technologically rational proportions between the traditional and radically new technology". Rumer concludes that, "Soviet machinebuilding is simply not prepared for "robotization".[16]

The MBMW sector will be hard pressed to meet the demands of the modernization program. For example, even if there is little or no growth in production of military hardware during the 12th Five-Year Plan, the 9 percent annual growth in consumer durables called for by Ryzhkov last June coupled with about an 11 percent annual increase in domestic production of producer durables needed to modernize Soviet production facilities (page 33 above), would require total machinery output to increase more than 9 percent a year. The recently approved 12th FYP calls for machinebuilding output to increase by only about 7.5 percent annually. Even this is ambitious given the recent track record of this sector. Such high output targets, moreover, will reinforce the built in reluctance of enterprise managers to standdown for renovation. As a

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[15] For a discussion of this issues, see Boris Rumer, "Realities of Gorbachev's Economic Program", *Problems of Communism*, May-June 1986, pp. 20–31.

[16] Rumer, "Realities of Gorbachev's Economic Program", *op. cit.*, p. 28.

result, production of old models of equipment is likely to continue instead of new, higher quality machinery needed to modernize.

There also is some question as to whether the overriding emphasis given to the renovation of existing facilities is the most appropriate investment strategy. The policy is predicated on the notion that it will reduce the demand for investment goods. But, the demand for investment is continuing to grow more rapidly than the planned supply of investment goods.

—The capital stock is so large in the USSR that replacing even a small portion of it annually requires a rising share of investment resources.

—The renovation approach is unworkable in large areas of the country. In the industrial heartland of the European USSR, many facilities are too obsolete to be reconstructed. In the Siberian and Eastern regions, there are relatively few facilities to renovate.[17]

—Demand for investment in high-priority programs, such as the Food Program, energy development, and the retooling of the machinebuilding sector, is growing rapidly.

Some economists have raised fundamental questions about the renovation approach itself. They question whether renovation necessarily results in a more efficient utilization of investment resources. For example, data provided by V.K. Fal'tsman, a prominent Soviet economist, suggests just the opposite. Fal'tsman surveyed 85 construction projects for the Soviet machine tool industry and found that the average duration of a project under renovation was 18 years compared to about 9 years if it is newly constructed.[18] Kushnirsky argues that new production facilities in the USSR produce higher quality output than do renovated plants.[19]

V. Imports—A Way Out?

Moscow could give its modernization program a shot in the arm by stepping up imports of advanced machinery and equipment. Indeed, it is likely that the ambitious targets set by Gorbachev will be difficult if not impossible to meet without increased imports of machinery and equipment. In the past, imported machinery has made up a substantial part of the equipment portion of total investment—as much as one-third or more. This equipment has played an important role in revitalizing selected Soviet industries.

Machinery imports from the West have the greatest potential benefit to the Soviet economy since they are, in general, the most technologically advanced. Nonetheless, the leadership has implied that imports of Western machinery will play a minor role in Moscow's modernization plans. This decision appears to reflect several factors:

—Moscow's desire to avoid dependence on imports of Western goods. The basis for this decision may be ideological but the

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[17] For a discussion of this issue see Boris Rumer, "Soviet Investment Policy: Unresolved Problems," *Problems of Communism* (September-October 1982), pp. 53-68.

[18] V.K. Fal'tsman, "Potential Investitsionnogo Mashinostroennia" *Nauka*, Moscow, 1981.

[19] F.I. Kushnirsky, "Gorbachev's Industrial Modernizations Programs: Feasibility, Benefits, and Costs," Unpublished.

grain embargo and sanctions imposed by the West in the early 1980s apparently are factors as well.

—Limits on Soviet exports that will reduce Moscow's capacity to import Western goods. In particular, Soviet hard currency earnings recently have dropped markedly due to falling oil prices.

—Disappointment with past gains from equipment and technology imported from the West.

Still, it is likely that the Soviets will be forced to turn to the West for at least some equipment, particularly if the modernization program begins to founder. In fact, Moscow already has begun exploring new ways—such as joint ventures—for dealing with Western firms.[20]

The Soviets are planning primarily on tapping Eastern Europe's well-developed and relatively sophisticated scientific and industrial base as a major source of industrial technology. They already import a substantial amount—roughly one-quarter of total Soviet investment in machinery—from CEMA countries. The recent appointments of two men with considerable East European experience—Boris Aristov as Minister of Foreign Trade and Nikolay Talyzin as Chairman of Gosplan—attest to the importance Gorbachev attaches to the region and to this policy.

The East Europeans are likely to resist exporting significantly greater quantities of equipment to the USSR. Moscow already absorbs a large share of East European production in high-technology industries and most of these countries lack the capacity to expand exports to the USSR much further. In addition, many of the CEMA countries have their own hard currency difficulties and would prefer to market their products in the West.

VI. Conclusions

Since assuming power a little more than a year ago, Gorbachev has moved quickly and aggressively in dealing with the problems of the ailing Soviet economy. He has identified the major problem areas and forged a long range economic program to revitalize the slumping economy. Some of these policies are not new, having been carried over from previous administrations. As a package, however, they probably represent the most intense effort to deal with Soviet economic problems in decades.

The changes in investment practices and policies contained in the 12th Five-Year Plan should provide some boost in economic growth in the USSR in the years ahead. In particular, the plan to raise retirement rates and to devote a much greater share of investment to the replacement of obsolescent capital should have a positive effect on the productivity of capital since the return to capital is higher for producer durables than for the longer-lived structural component of the capital stock. In the past, the prolonged retention of obsolescent, low productivity capital together with the relatively low proportion of investment devoted to replacement of obsolescent assets has been a major drain on the economy. Accord-

[20] The Soviets are also seeking membership in GATT and are in the process of reorganizing their Foreign Trade apparatus.

ing to Stanley Cohn, it has accounted for about half of the negative trend in capital productivity over the past several decades.[21]

A further boost in productivity can be expected from the mechanization and automation of production, particularly of auxiliary (warehousing, loading-unloading, and repair activities) processes. One third of all workers in industry, one half of construction workers, and two thirds of agricultural laborers currently do difficult manual labor in the USSR.[22]

It is doubtful, however, that the economy will achieve the level of performance the new regime is seeking. Clearly very difficult obstacles have to be overcome. Gorbachev's investment policies, for example, are likely to be less effective than needed without major changes in the Soviet incentive and planning system. These are the same kind of obstacles that have frustrated the efforts of previous administrations in finding solutions to Moscow's economic problems. Moreover, the lack of consistency and balance in these plans is likely to cause bottlenecks and supply constraints which will limit investment growth and cripple Gorbachev's plans for modernizing the economy. Most damaging of all, the regime's efforts to raise the quality of investment likely will fall short of expectations. The machine-building industries are not going to be able to sustain the high rates of production nor achieve the improvements in product quality needed to renovate existing firms and boost the rate of technological change on the scale that Gorbachev has called for.

Should the investment program begin to founder, the leadership likely would consider some or all of the following options:

—Imports of Western technology could be stepped up. However, as discussed above, hard currency constraints and difficulties in assimilating and diffusing Western equipment will limit the amount and effectiveness of such imports.

—More domestic machinery capacity could be freed up by cutting down on the frequency and duration of repairs and by going to two or three shift operations. Such a policy, however, could have disastrous long term implications. Major breakdowns would be likely after a short period given the age and condition of many Soviet machines.

—Production of military hardware could be cut back in order to free-up capacity to manufacture more producer durables. Growth in military procurement has been stagnant for nearly a decade, however, and further reductions probably would be vigorously resisted by military leaders.

—The large volume of unfinished construction could be reduced. The commissioning of these idle assets would provide at best only a one-time boost to the existing capital stock, however, not a continuous infusion of fixed capital. Furthermore, the boost would be relatively small.

—Major systematic changes could be made in the planning and management of investment (creating capital markets,

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[21] Stanley H. Cohn, "Sources of Low Productivity in Soviet Capital Investment". "Soviet Economy in the 1980s: Problems and Prospects," Joint Economic Committee, Congress of the United States, 97th Congress, 2nd Session, December 31, 1982.

[22] Pravda, 29 August 1986, p. 1.

market determined prices, etc.). However, Gorbachev thus far has shown no inclination to choose such a path.

Because Gorbachev's program is likely to come up short, the Soviets could face more difficult problems in the future. Indeed the crunch point could come as early as 1988 or 1989. By that time, all major output claimants are likely to be demanding a greater share of GNP. The military will need more new investment for defense plant and production equipment in order to tool up for the next generation of weapons. Pressure to increase the share of resources going to consumer programs is almost certain to increase as well. Soviet living standards have increased little in recent years and Gorbachev's promises to improve the lot of Soviet citizens have raised expectations which will be difficult to ignore. Meanwhile, the need for more investment to bolster the modernization program—which by then is likely to be bearing less fruit than expected—will be increasing. These pressures could lead to a heated political debate and present a major test of Gorbachev's leadership when planning for the 13th Five-Year Plan period begins.

The outcome of Soviet-U.S. arms control negotiations likely will impact on these events. If an arms control agreement is reached, some of the pressure will be off the Gorbachev regime. More of the resources that otherwise would have gone to defense will be available to keep the modernization effort afloat and to bolster consumer programs. However, should the arms talks fail, the competiiion for resources in the USSR could become more intense than at any time in the postwar era.

THE ROLE OF INDUSTRIAL MODERNIZATION IN SOVIET ECONOMIC PLANNING

By F.I. Kushnirsky*

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SUMMARY

Recent developments demonstrate that Gorbachev wants to improve Soviet economic performance, first of all, by a more consistent and rigorous use of traditional tools, industrial modernization being the most notable. Additonal material inputs will be provided to the technological change process, especially in the machine-building sector: automation and mechanization are planned at a large scale, and organizational changes are under way in the Soviet R&D system. The investment process is to concentrate on the renovation of existing plants, rather than on new construction, and on the acceleration of retirement turnover for production capital stock. The revision of the procedures for product quality certification and of the country's technical standards, the introduction of state quality control at production firms, and the increase of rewards for quality improvements, on the one hand, and of penalties for waste and defective products, on the other hand, are intended to address the notorious problem of poor goods quality.

The analysis of Soviet modernization targets reveals their over-ambitious nature. Yet, even if they were feasible, the experience of other similar Soviet campaigns suggests that the advances of the modernization program will be limited to the designated industries and will barely affect the rest of the economy. The support of the modernization drive on the part of the management is far from unanimous. Although, hypothetically, technological change reduces the consumption of production inputs, Soviet managers do not know how to solve the problem of inadequate supplies now. For this reason, the leadership's commands to accelerate both technological change and economic growth seem to be incompatible. Gor-

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bachev's modernization program is not consistent with a reform approach, for it does not promote entrepreneurship, personal financial liability, and market competition.

1. Introduction

Both Soviet leaders and Western analysts accept as fact the low pace of technological change in the Soviet economy. Yet it may be wrong to conclude that there are insufficient resources available for the Soviets' technological change process. In a free-market economy, where many firms may be involved in the same type of research, with an inevitable repetition, high levels of industry spending on research and development (R&D) do not always yield an adequate output. Therefore, a positive correlation between input and output from the process of technological change may or may not be high, depending on the market structure in which the firm operates. According to Soviet political economy, the liquidation of the "anarchy of capitalist production" there led to a better coordination and, as a result, less excessive repetition in the R&D process. Consequently, the Soviet process of technological change should be more efficient than in the West, in the sense that they would need less inputs to achieve a comparable output. In reality, however, one finds an opposite result: Soviet goods, expecially machines, are heavier than their Western counterparts, or less versatile, or less convenient for the user.[1] Some well known examples of Soviet production inefficiency are stressed in a *Samizdat* memorandum that became available to Westerners.[2] Thus, while there is a shortage of metals in the country, their useful consumption accounts for only 70 percent of the total, and in some technologies it does not exceed 20 to 30 percent. There is a grain shortage, but its waste in harvesting and transporting amounts to 30 percent. (In his speech in June 1986, Gorbachev names 20, not 30 percent.[3]) The waste and spoilage of fruits and vegetables are in excess of 60 percent. There are shortages of oil, with the production being the largest in the world, or paper, with forest resources being the richest in the world. The list of examples could be extended.

The systematic problems of waste and inefficiency must affect other sectors of the Soviet economy, including the process of technological change. Significant resources spent on technological improvements since the mid-1960s did not materialize in an adequate improvement of Soviet goods and services. Inadequate technological change in turn aggravated inefficiency. Gorbachev's economic program intends to cut this twofold relationship by addressing the problem of inadequate technological change. He views rapid industrial modernization as an answer to Soviet economic problems. But what can be accomplished within the existing economic model? Given that this model promotes inefficiency and waste, to what

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[1] This is documented for Soviet machines, for example, in a research paper "USSR and the United States: Price Ratios for Machinery, 1967 Rubles—1972 Dollars," Volume II, National Foreign Assessment Center, Washington, D.C., 1980. Of the 245 Soviet machines and their U.S. analogues compared, the latter are, if not lighter, more productive, or more versatile, or more accurate.

[2] Excerpts from the memorandum were first published in English by The Guardian on July 22, 1986. The full text was then printed in Russian by Novoe Russkoe Slovo on August 6–8, 1986.

[3] Gorbachev, M.S., Speech at the Plenum of the Central Committee, Pravda, June 17, 1986:3.

extent is the program of industrial modernization feasible? If the program hits its target, will it bring about the targeted revival of the Soviet economy? This paper will address these and related questions.

2. The Vision of the Technological Change Process

With an emphasis on technological modernization, the 12th five-year plan (1986–90) is declared to be the plan of efficiency, as in the past there were plans of quality or of productivity. The role of technological improvements as an integral part of the national economic plan was strengthened in the 1960s. Plans for mechanization and automation of technological processes were drafted in the past, too, but they did not have a synthesizing indicator that could measure the overall change of the state of technology. It was then decided to stress the introduction of prototypes of new goods and their first production runs as central indicators of the plan for new technology and to link them closely to the production plan. Eventually, planning of goods of the high quality category surpassed in importance the other indicators of the plan for new technology in the late-1970s. More direct links were also established between this plan, on the one hand, and investment, labor, and cost-of-production plans, on the other.

Of the different improvements associated with technological change, the saving of material inputs was not paid much attention after the introduction of the 1965 economic reform. The rationale was that, under incentive provisions, the firm would find it profitable to reduce the consumption of production inputs on its own. But, since no incentives worked in that direction, growing production costs alarmed planners. Their appeal for a return to the direct planning of costs was heeded to by the party authorities only when the supplies of metals and energy to the domestic market were further strained. As a result, expenditure of material inputs emerged as one of the most important indicators of the plan for new technology. To be sure, resolutions on saving energy, metals, and other materials had repeatedly been approved in the past, but only in the 1980s were they implemented in mandatory targets specifying concrete reductions of supplies to industrial ministries. Assignments for saving material inputs (*rezhim ekonomii*) have been strengthened in the 12th five-year plan. As a result, the ratio of material expenditure to national income is to decline by 4 to 5 percent (the decline reported for the 1981–85 period was 2.5 percent), the ratio of energy expenditure to national income, by the same percentage, and the ratio of metal expenditure to national income, by 13 to 15 percent.[4] Construction is supposed to save 13 to 15 percent of rolled metals, 8 to 10 percent of cement, and 10 to 12 percent of timber materials. As is usual for national economic plans, these targets for saving material inputs are too taut to be realistic and, at the same time, too modest to incorporate the revolutionary changes in the efficiency of machines and equipment that are projected for the 12th five-year plan.

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[4] Narkhoz SSSR 1985:57 and Pravda, Jan. 26, 1986:1.

Along with saving material inputs, the new, advanced technologies to be introduced in the 1986–90 period are supposed to improve work conditions by automating and mechanizing production. Automation has been a dream for all Soviet leaders after Stalin; they could not stand the idea of millions of workers employed in unproductive manual jobs. However, Gorbachev claims that little was actually done in the past to secure the meeting of plan targets for automation. According to the new plan, automation is to double by 1990, with a special emphasis on the MBMW sector. The new plans are based on the introduction of flexible automation systems, rotor and conveyor lines, microprocessor devices, robots and computers. The Soviets have manufactured their computers since the 1960s, after the anathema was removed from cybernetics. Although significant progress was made, Soviet hardware and software, especially the latter, remain of poor quality. Counter to the intent and the whole idea of computerized data processing, the expanded use of computers led to a higher, not lower demand for data processing personnel. The use of computers is still a responsibility of a small group of programmers and analysts who are isolated from the rest of employees in a research institute or an industrial firm. The authorities view the mass production of personal computers as a golden opportunity for involving a broader circle of white collar workers in computerized data processing. Western analysts may be misled by the term "personal," but these computers will be produced by Soviet industry primarily for offices and schools, not for private, personal use. The production of computers is to surge 2.4 times in the 1986–90 period; of those 1.1 million will be personal computers for which the technology of manufacturing is being established.[5] (For comparison, 5 million personal computers were manufactured in the U.S. in 1984.)[6]

For the economy to benefit from advanced technologies, automates and computers, the equipment must be delivered and used properly. That is why the Soviet authorities are concerned with the efficiency of their R&D units and the misuse of sophisticated equipment. Although there is nothing new about these concerns, some organizational changes in R&D and some stiffer punishments for failures to promote technological change have been introduced. In some of the recent demonstrations, the Central Committee passed several resolutions, for example, reprimanding the Ministry of Machine Tool and Tool Making Industry for manufacturing dated equipment and the Ministry of Radio Industry for manufacturing poor-quality consumer goods.[7] According to the resolutions, "mobilizing" their subordinate firms to intensify technological improvements is the main task of ministerial party committees and local party authorities.

The Soviet system of research organizations includes R&D units at industrial firms, project and research institutes at the ministries and departments (including the Union-republic *Gosplan* system), institutes of the Academy of Sciences and research divisions at

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[5] Gorbachev, M.S., op. cit.:2.
[6] *Statistical Abstract of the U.S.*, U.S. Department of Commerce, Washington, D.C., 1986:770.
[7] Partkom ministerstva, Ekonomicheskaia Gazeta 7, Feb. 1986; and V Tsentral'nom Komitete KPSS, Pravda, June 3, 1986:1.

higher education institutions. According to Soviet sources, there were 1.5 million researchers in the country in 1985; this is reported to be one fourth of the world total.[8] In 1985 the state budget outlays for R&D were 28.6 billion rubles, or 5 percent of the national income used for consumption and accumulation.[9] (This may account for less than half of total R&D expenditures; the rest are covered by production costs.) The figures characterize a large scale of inputs to the technological change process. Here is, however, how Gorbachev sees the output:

> Our production structure remained rigid and fell short of the requirements of technological progress. The USSR produces much more of iron ore and steel than the U.S., with significantly lower output of machine-building products, prepares the same amount of wood but produces less wood products. Each incremental unit of national income, industrial and agricultural output requires from us more resources under these conditions.[10]

Among the causes that Gorbachev indicates are miscalculations in the investment policy, neglect of the needs of existing plants, especially in the MBMW sector, creation of artificial labor shortages, waste, etc. But those are effects rather than causes.

Much attention is now being paid to the low efficiency of Soviet R&D units, in particular those designing new machines and equipment. Blaming designers for the failure to take into account the highest world standards, Gorbachev accused them of having an inferiority syndrome and of peddling eyewash.[11] In a recent demonstration of their concern with the situation, the Central Committee approved the guidelines for improvements in the higher and secondary special education, and the Council of Ministers passed a resolution on the shortcomings in the activities of ministerial research and project institutes.[12] One of the thrusts of the guidelines is the integration of higher education with production, a move that would add some muscle to applied research at universities but would not make theoreticians happy. While there was also criticism toward ministerial research and project institutes in the past, this time there are interesting new developments in the Council of Ministers resolution. Namely, two institutes—of the chemical machinery and of the machine tool industry—that were charged with fruitfulness will be liquidated. Apparently, the two institutes and their 1300 employees who will be placed in other jobs, were picked as scapegoats, for the Council of Ministers could easily find many other similar institutes. Yet the measure, unprecedented in the Soviet history, is to send a message to all researchers and designers.

The new Soviet leaders realize the need for reducing the underemployment in their huge R&D system which, rightly or wrongly, has become anecdotal. Since what should be done may not have been clear, several experiments that were initiated earlier are endorsed. One is aimed at the creation of research and production associations (*NPO—nauchno-proizvodstvennye ob'edineniia*) that began in the 1970s. Most of those NPOs were subordinate to the

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[8] Narkhoz SSSR, 1985:64. In a report "Statistics on Research and Development Employment in the U.S.S.R.," U.S. Department of Commerce, Washington, D.C., 1981:44, Nolting and Feshbach estimated about one million researchers there in 1979.

[9] Narkhoz SSSR, 1985:561.

[10] Gorbachev, M.S., op. cit.:2.

[11] Gorbachev, M.S., op. cit.:2

[12] Pravda, Jun. 1, 1986:1-3 and Ekonomicheskaia Gazeta 27, Jul. 86:3.

ministries. In spite of the intent, the links of many of the ministerial institutes to production firms remained loose. In 1985 it was decided to transfer the bulk of the ministerial institutes to production associations, in order to raise incentives and to strengthen the researchers' responsibility for the application of their findings. In one of the attempts to remove the stumbling block in the way of NPOs—the separation of research and production—the first VNPO (*vsesoiuznoe NPO*) was just organized. The potential advantages of VNPO are that, at such a gigantic level, it is possible to combine powerful research organizations, design and project institutes and production firms.[13] Yet industrial production associations, that replaced ministerial *glavki* and that in turn will probably be replaced by VNPOs, possessed the same authority over all organizations and firms subordinate to them, but they did not succeed. Although the appointment of more qualified management to VNPOs may make a difference, the problem is that, in combining research and production, the Soviet leaders want to have their cake and eat it too. In reality, however, if production targets are taut, all the units of any associations will work toward the meeting of those targets and will forget about experimentation with new goods and new technologies. If, on the other hand, the plan targets are loosened, and experimentation is stressed, where will the production come from, and how will the acceleration (*uskorenie*) declared by Gorbachev be possible?

There is also another new form of industrial organization praised by Gorbachev at the 27th party congress, the interbranch R&D complexes (*MNTK—mezhotraslevye nauchno-tekhnicheskie kompleksy*). Unlike VNPOs, MNTKs are not charged with both research and mass production; their responsibility will stop at the manufacturing of prototypes. The first brand new MNTK embraces 14 organizations of the Academy of Sciences and five ministries, the chemical, petrochemical, fertilizer, chemical machinery, and instrument making industries.[14] The main organizational difficulties facing MNTKs are related to the decision making process and the distribution of investment and supplies. The Soviets have a negative experience of attempts at breaking ministerial barriers when, for example, the branch-of-industry and territorial aspects of planning had to be coordinated. Since the plan assumes a strict principle of responsibility for the spending of each specific input (*adresnyi kharakter*), in most cases the ministries were recipients of funds, and the branch-of-industry aspect clearly dominated over the territorial. Only supraministerial power possessed by bureaucratic bodies such as the new Agroindustrial Committee and the Bureau for Machine Building will enable them to solve problems that involve several ministries. Since the new MNTKs cannot be given a supraministerial status, a related deputy minister will control each ministry's organizations involved in the MNTK, and a deputy director of the MNTK will be appointed to coordinate problems with each of the ministries. This is a traditional Soviet ap-

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[13] Some of the advantages are discussed in "Na triokh kitakh," Interview with Beliakov, V.P., Izvestiia, Aug. 19, 1986:2.

[14] MNTK: shagi stanovleniia, Interview with Zamaraev, K.I., Ekonomicheskaia Gazeta 21, May 1986:21.

proach, except that the people responsible for the coordination will have higher than usual ranks. One can, however, be skeptical whether such a change will make any difference for the MNTK performance, especially as more of them are organized and as preferential treatment in terms of supplies shrinks.

Another experiment in the Soviet R&D system, this time with wages, involves 70 research organizations of 33 ministries employing 60,000 people.[15] Directors of those organizations set guaranteed minimum wages for all employees at the level of 70 to 80 percent of existing regular salaries. Depending on performance, every worker can "earn" an additional portion of his wage which, together with an incentive bonus, may even exceed his former salary, up to a certain cap. Although subject to abuse, this new system will give some greater leverage to administration that only has an ability to reward conscientious workers and cannot penalize those who are indolent or incompetent.

3. Technological Change and Investment

The role of investment plans in inducing technological change in the Soviet economy has persistently grown since the 1960s. New targets linking the two plans were imposed, and industrial firms were required to submit their plans for investment in technological renovation and modernization. The following figures characterize investment growth by five-year periods since 1960: 1961–65, 45.1 percent; 1966–70, 42.6 percent; 1971–75, 41.3 percent; 1976–80, 27.5 percent; 1981–85, 15.4 percent.[16] Of the several different versions, a 23.6 percent growth seems to be the last one approved for the 1986–90 period.[17] There were many speculations as to the reasons for a low rate of investment growth in the 11th five-year plan. A sharp decline of the projected growth puzzled Western analysts when the guidelines for the 11th five-year plan were first published in 1981. The rationale, however, was in the attempt to switch from extensive growth, based on the use of additional resources in the production process, to intensive growth, based on an increase in marginal productivity. With an emphasis on the use of more machines and equipment, the proportion of construction and installation work had to be decreased accordingly, by several percentage points, as provided by the plan. In combination with a projected shift to the completion of projects started earlier, a process slower than new construction, this had to result in an unusually low volume of investment for the 11th five-year plan. Yet, as usual in Soviet planning, annual plans brought about significant alterations. In literary terms, the five-year plan outlines how the economy *should* perform, and the annual plan shows how the economy *can* perform. By making five-year plans more realistic and more concrete, the authorities have reduced that discrepancy, but it is still big. In the case of 1981–85 investment, the initiation of new construction

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[15] Kozhevnikov, R., Ekonomicheskoe stimulirovanie nauchno-tekhnicheskogo progressa, *Planovoe Khoziaistvo* 3, 1986:65.

[16] Narkhoz SSSR, 1985:363 and Gorbachev, M.S., op. cit.:2. A downward revision of the 1981–85 growth took place in just several months, for at the party congress in February 1986 Ryzhkov cited a 17 percent growth for that period (Ekonomicheskaia Gazeta 11, March 1986:23) also documented in Narkhoz 1985, not 15.4 percent as follows from Gorbachev's speech in June 1986.

[17] Gorbachev, M.S., op. cit.:2.

projects, at a pace higher than initially planned, and the corresponding reduction of funds available to renovation, led to the rare incident of surpassing the plan.

This time Gorbachev wants everything to go differently. He believes that slowing down the investment growth was a bad idea; instead, investment should grow faster, to enable the economy to modernize its huge capital stock. The highest growth is foreseen for investment in renovation, which is to increase 1.7 times in the 1986–90 period, and its share in total investment will continue an upward trend, from 38.5 percent in 1985 to 50.5 percent in 1990.[18] As a result of an advancement in the renovation process, a change in the composition of production capital stock is expected: capital stock in machines and equipment will grow, while in buildings and structures it will decline. This is to be accomplished by raising the retirement rates for capital stock, accelerating its turnover, and thus modernizing the technological base of all sectors of the economy. Since this process of technological modernization is the key to Gorbachev's campaign for the drastic revival of the Soviet economy, two questions emerge. Is it feasible? What are the potential benefits for the Soviet economy?

There is much discussion in economic literature, including the Soviet literature, on the obsolescence of Soviet production capital and declining rates of its retirement. Table 1 shows average ratios of the costs of retired capital to the cost of total industrial production capital for the 1971–85 period. For comparison, normative, i.e., planned ratios for retirement, an increase of which happened in 1975, are also provided. The normative ratio shown is a weighted average for different industries whose individual normative ratios vary from 3.2 percent for energy machinery to 5.6 percent for instrument making.[19] As one can see from Table 1, actual retirement ratios were much lower than the normative ones. For machines and equipment the retirement ratios were more stable, floating about 2.5 percent in the 1971–85 period.[20] While there are many reasons for the low actual retirement ratios, the shortage of new equipment was the most important one. In some instances production firms are simply not interested in replacing their old equipment, for the new machines may have no advantages and may be more costly and more difficult to install and use.

TABLE 1.—RETIREMENT RATIOS FOR SOVIET INDUSTRIAL PRODUCTION CAPITAL, PERCENT

Indicator	1971–75	1976–80	1981–85
Total retirement ratio	11	8	8
Average annual ratio	2.2	1.6	1.6
Annual normative ratio	3.7	4.8	4.8

Sources: Narkhoz SSSR, 1985:123 and Senchagov, V. and V. Ostapenko, Znachenie amortizatsii v tekhnicheskoi rekonstruktsii, Voprosy Ekonomiki 1, 1981:36.

By imposing much higher and, most importantly, mandatory retirement rates for equipment, Gorbachev wants to demonstrate

[18] Pyzkhov, N.I., Ekonomicheskaia Gazeta 26, June 1986:12–13.
[19] Senchagov, V. and V. Ostapenko, Znachenie amortizatsii v tekhnicheskoi rekonstruktsii, Voprosy Ekonomiki 1, 1981:37.
[20] Narkhoz SSSR, 1970:169, 1980:147, and 1985:124.

that he is serious about technological modernization. The average retirement ratio for machines and equipment will increase by 5 to 6 percent.[21] What growth rates does that command for the MBMW sector? To figure it out, one should take into account both the change in the retirement rates and in the composition of production capital. First, as indicated above, in 1985 the equipment retirement ratio was 2.5 percent of the cost of production capital stock. That stock consists of buildings, installations, equipment, and other smaller items; equipment was 39.9 percent of capital stock by the end of 1985.[22] Hence, the retirement ratio with respect to the stock of equipment was 6.27 percent (2.5÷0.399), and the average age of equipment was 16 years (100÷6.27) in 1985. Second, the composition of capital is supposed to change gradually in favor of equipment, whose share of capital stock rose at the rate of 0.82 percent in the 1981–85 period. Assuming this growth rate for the 1986–90 period, the proportion of machines and equipment will reach 42 percent in 1990. The average 5.5 percent retirement ratio for capital thus turns into 13.1 percent (5.5÷0.42) of the cost of machines and equipment. Consequently, this ratio implies an average projected age of machines of 7.6 years (100÷13.1). If, at the existing production growth rates for the MBMW sector, the average age of machines was 16 years in 1985, then the new 7.6 year age in 1990 will require MBMW growth rates to be 2.1 times (16÷7.6) higher. Therefore, if the projected average age of machines and equipment stabilizes at the level between 7 to 8 years, the MBMW sector production must grow 2 to 2.3 times as rapidly as it did in the 11th five-year period. A Soviet writer, Malygin, arrives at similar results by finding that a twofold acceleration in MBMW growth will be needed to maintain a lower, 4 percent retirement ratio.[23]

Then what can be expected from the planned 43 percent growth for the sector in the 1986–90 period if it rose by 35 percent in the 11th five-year period?[24] Computation shows that, unless new sources of production or import are found, the machinery average age can be lowered to 13 years, with the retirement ratio consequently raised only by about one percentage point from the existing 2.5 percent. This computation does not even take into account the fact that the pace of new construction will inevitably be higher than initially planned, which will siphon off additional equipment from the renovation process. Also, improvements in machine quality, along with relevant incentive provisions, will hike machine prices and thus reduce real growth rates. Some Soviet authors also expressed their concerns about the inconsistency between the plan targets for the renovation of capital stock in the economy and the projected growth for the MBMW sector.[25]

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[21] Ryzhkov, N.I., Ekonomicheskaia Gazeta 11, Mar. 1986:26.

[22] Narkhoz SSSR, 1985:119.

[23] Malygin, A., Obnovlenie osnovnykh proizvodstvennykh fondov, Planovoe Khoziaistvo 7, 1985:34.

[24] Ryzkov, N.I., Ekonomicheskaia Gazeta 26, June 1986:13 and Narkhoz 1985:129.

[25] Such concerns were expressed at discussions organized prior to the approval of the guidelines for the 12th five-year plan. See, for example, comments by Palterovich, D.M., in Voprosy Ekonomiki 1, 1986:66 or by Loginov, V.P., in Planovoe Khoziaistvo 1, 1986:21. Inviting scholars to express their views on the final draft of the plan openly has been unprecedented since the mid-1960s.

Doubtless, high turnover of capital by itself is not a panacea. For example, in the 1977–78 period when the retirement ratio for industrial capital was 2.4 percent, that ratio was 10.1 percent for agriculture and 7.6 percent for construction.[26] But this is not a sign of superiority for those areas. Instead, it reflects misuse, poor maintenance, and the lack of proper storage. In the process of capital replacement, the age of machines should not be decisive. With what are they replaced? Soviet authors indicate that if the efficiency of a new machine is not greater than 1.5 to 2 times that of the older one, the replacement is not economically justified.[27] This puts the problem in the proper perspective of machine quality, rather than turnover *per se*. Meanwhile, in anticipation of the consequences of the capital turnover campaign, it is easy to imagine the amounts of useful equipment that will be scrapped by Soviet managers. (In the U.S., the markets for used and renovated machines and equipment prevent the scrapping of useful capital stock, since market prices for such capital exceed the scrap values.)

Many analysts, both in the West and in the Soviet Union, believe that the renovation of Soviet industrial capital is more efficient than new construction. Thus, according to the Gosplan's Summary Department of Capital Investment, renovation pays off three times faster, requires a 27 percent shorter project duration, and has a 1.5 times higher output-to-capital ratio than new construction.[28] Yet, since renovation is not welcome everywhere, one may, without challenging these figures, suspect that the data must be somewhat hypothetical. Table 2 provides several alternative characteristics of efficiency for new construction, renovation, and production expansion. (The latter is a process in which new shops are added to existing plants.) The information was obtained by surveying 85 construction projects for the machine tool industry. As Table 2 demonstrates, the investment-to-output ratio was lower for renovation compared to new construction. However, the ratio of the years required for the completion of a project to the amount of investment and the average duration of a project were significantly higher for renovation than for new construction. Many other sources also point to problems with the renovation process, such as high labor costs and low profits of renovation projects.[29] Yet the chief problem, in my view, is not the efficiency of the investment process, *per se*, but its effects on the improvement of product quality. From this standpoint, newly introduced plants are superior to those that are only partially renewed. Further, as indicated by Soviet sources, the correlation between capital turnover and resulting improvement in product quality has not been significant thus far.[30] Hence, Soviet quality problems will not be solved by the "optimization" of investment policies, even if all of the obstacles cited above are removed so that Gorbachev's plans for renovation can work.

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[26] Palterovich, D.M., Obnovlenie oborudovaniia i tekhnicheskoe perevooruzhenie proizvodstva, Planovoe Khoziaistvo 9, 1980:103.
[27] Palterovich, D.M., op. cit.: 109.
[28] Stepun, A., O ratsional'nom napravlenii kapital'nykh vlozhenii v IIi piatiletke, Planovoe Khoziaistvo 10, 1981:35.
[29] Rumer, Boris, Soviet Investment Policy: Unresolved Problems, Problems of Communism, Sep.-Oct. 1982:60.
[30] Fal'tsman, V.K., Potentsial investitsionnogo mashinostroeniia, Moscow, 1981:177.

TABLE 2.—EFFICIENCY OF DIFFERENT INVESTMENT STRATEGIES

Type of investment strategy	Number of projects	Share of total cost, percent	Investment-to-output ratio	Number of years per million rubles of investment	Average duration of a project, years
Renovation	42	34	.92	1.34	18.3
Expansion	31	49	.90	.49	15.7
New construction	12	17	1.03	.30	8.9

Source: Fal'tsman, V.K., Potentsial investitsionnogo mashinostroenia. Moscow, Nauka, 1981:77

4. The Quality Problem

Soviet authorities have for a long time stressed the necessity of approaching economic planning from the targeted final results, rather than from gross value indicators. Whether the change in emphasis can improve the final results is another story, but the fact of the matter is that some relevant adjustments have been made in the planning methodology. Looking at the final results of the industrial modernization drive, improvements in product quality seem to be the logical prime target. What can and will Gorbachev do to attack the notorious problem of poor product quality? To the Western reader, the problem of product quality may seem less important than other economic problems. He knows that, if a poor quality product is not sold, the producer will be forced to improve the product or, if it is sold, the producer will be forced to give the consumer a (ceteris paribus) better price. Yet this generally plausible assumption does not apply when products of different quality are not equally attainable, a condition that is true in the Soviet case. Moreover, the quality problem turns into a quantity problem when defective goods are manufactured. The scale of the problem was illustrated by Gorbachev himself with an example of millions of meters of fabrics, pairs of shoes and other consumer goods returned to the producer or otherwise transferred to a low quality category in 1985.[31] He does not elaborate on the amount of damage but asserts that, as a result of the wasted material inputs and the wasted labor of hundreds of thousands of people, it was enormous.

In my view, there is uncertainty among the authorities as to the best specific policies for improving quality. Issues like investment priorities or introducing computers can be treated, at least in part, separately. But the quality problem is a systematic disease that makes the authorities feel uncomfortable about recommending treatment. They have used administrative controls and punishments, direct planning, standardization, price mechanisms, product certification, material incentives and moral persuasion. The policies for product quality improvements implemented in the 12th five-year plan are based on numerous resolutions approved prior to Gorbachev's rise to leadership. Even the new resolutions passed by the Central Committee mostly restated earlier decisions. One new provision may have a minimum potential impact on the economy, but it is indicative of the authorities' awareness that the worker's

[31] Gorbachev, M.S., Speech at the 27th party congress, Pravda, Feb. 26, 1986:5.

own pocket is more important to him than that of his firm. Since 1986 the cost of a producer's repair of defective products must come directly from the firm's material incentive fund *(fond material'nogo pooshchreniia).*[32] For each one percent of the share of defective products in the total value of output, the penalty is 5 percent up to a maximum of 20 percent of the material incentive fund, which is a source of bonuses for some workers. This provision is interesting because, thus far, sanctions had been used against the firm, not against its employees. One should yet realize that plant management does not make up its own production plan. The decision rests with *Gosplan* or the ministry. Then why do they allow poor quality? One possible explanation is that, when a product grows obsolete but is still in demand, it may not be discontinued without finding a substitute. If, however, an R&D facility could not be assigned to develop a new product, if the outcome of such a project is not adequate, or if the deadline is not met, *Gosplan* will have no options but to permit the continued production of old goods. This type of a situation is illustrated by a director of an oil refinery from Baku who, in a Schiller style article, laments on the "treachery" of shortages.[33] His refinery turns out poor quality motor oil. Since motor oil is in short supply, industrial users buy it and do not dare to complain. The refinery is incapable of improving the oil's quality, but when its director appeals for help to the ministry and its research institute, they do not listen: Why does he complain when his customers do not? The story illustrates just one of the problems that the Soviet manager is faced with; if the ministry or its research institute told their stories, they could point to their own problems.

Since the authorities realize that it is more difficult for the plan to take care of product qualities than quantities, they use several procedures to besiege the fortress from different sides. One of the most important procedures is based on planning the proportion of goods in the high quality category, while the awarding of the category to new machines and equipment involves comparisons to their analogues, i.e., existing similar models and/or to standards. Mandatory targets for manufacturing high quality products have been imposed since the 10th five-year plan (1976–80), although the process of product certification goes back to the 1960s and became required in the 1970s. Special state committees certified high quality goods, and the ministries took care of certifying the first and the second categories. A major change was brought about by the new, 1984 instruction for certification.[34] Ministerial committees were abolished, and certification was centralized in the hands of state committees. Only the high and the first categories are to be applied, with the embarassing second category eliminated. One may question the effects of the change in the number of categories awarded on product quality. But the decision arose from the authorities' attempt to scrutinize the whole certification process. If one accepts

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[32] The July 1985 resolution of the Central Committee and Council of Ministers on new economic mechanisms and their impact on the acceleration of technological change, Ekonomicheskaia Gazeta 32, Aug. 1985:11–14.

[33] Kuliev, R.B., Kovarstvo defitsita, Ekonomicheskaia Gazeta 3, Jan. 1986:11.

[34] Poriadok attestatsii promyshlennoi produktsii po dvum kategoriiam kachestva, Ekonomicheskaia Gazeta 13, Mar. 1984:17–18.

such madness as certification of all of the goods manufactured in the economy, at least the process should not be a farce. But it does seem to be a farce when, along with widespread clamoring for better quality, there were too many goods in the first category and too few in the second. The well-known reason is that it was easy for a ministry to solicit an agreement from potential users to put low quality goods into the first category. Threatened by a potential delay in supplies, triggered by delays in product certification and production, the user would generally be cooperative.

The 12th five-year plan calls for doubling the proportion of goods in the high quality category of industrial output, while the certification process is to become more thorough and "objective". Surcharges awarded to products certified as being in the high quality category will become more generous, i.e., up to 30 percent of the price.[35] (For comparison, the average proportion of the surcharges in the MBMW sector, where the bulk of those products are made, was some 6 to 7 percent in the early 1980s.[36]) Additional surcharges of up to 20 percent of the price will be awarded to products exported and sold only for hard currency. The combination of two developments—increases in the proportion of products in the high quality category and in the size of the surcharge—may accelerate the inflation of producer-goods prices, especially for machines and equipment. Yet, with an emphasis on modernization and quality improvements, the problem of rising prices has become temporarily less important to the Soviet authorities.

Although, as noted above, Gorbachev does not suggest new approaches to the problem of lagging product quality, he does demonstrate a much better understanding of the necessity to use the stick as well as the carrot. To be sure, there was no shortage of stick in the past, but Gorbachev wants to use an economic stick that will hurt one's own pocket. Thus, for the first time in the planning of product quality, price discounts will be applied to the first category goods at the rates of 5, 10, or 15 percent of the price in the first, second, or third year of production, respectively.[37] Price discounts in the past had meant nothing to plant management, but this time up to 70 percent of the discounts are to be withheld from the material incentive fund which, as noted above, provides potential bonuses, primarily for white collar workers. Beyond price discounts and surcharges, only minor changes in price mechanism are suggested. For example, industrial firms will not need their superiors' approval for setting some temporary prices or for selling discontinued consumer goods at prices slashed up to 50 percent.[38] Other than that, so far the authorities do not go beyond calls for the improvement of the price system. The reason is simple. Flexible prices and planning are incompatible. If prices change in the plan's period of validity, the plan itself becomes useless. This happened to the 11th five-year plan, which exists only in a report.

Soviet managers seem to be bound hand and foot by the new regulations pushing them to produce better quality goods, but loop-

[35] The July 1985 resolution, op. cit.:11.
[36] Glushkov, N., O novykh optovykh tsenakh 1982 goda, Ekonomicheskaia Gazeta 18, May 1982.
[37] The July 1985 resolution, op. cit.:11.
[38] The July 1985 resolution, op. cit.:12.

holes will still exist. Realizing that quality improvements will not snowball and that, in many instances, poor quality goods will remain the only option, *Gosplan* will be allowed to include in the national economic plan some products that cannot be certified according to established regulations. Those will be the products that were in the old second category or products in the first category for which terms will expire. The new provision is that the first category cannot be awarded for a second term, usually in three years after the first certification, and, unless the product is upgraded to the level of the high category, it must be discontinued. Noncertified products will be allowed for no longer than two years, with a 30 percent price discount. The ministries will have to justify their proposals for manufacturing such products, and one can suspect there will be plenty of these proposals.

A shake-up in Soviet standards (*GOST*) is going on now. The purpose is to improve the normative planning of technical parameters. In the 12th five-year plan, new, "prospective" standards at the highest world level are to be created. However, Soviet managers complain that they do not know the parameters of new machines at the level of world standards, and thus they cannot plan for them. A new resolution of the Central Committee and the Council of Ministers calls for the creation of a national informational system on the best domestic and world standards.[39] However, even if it were possible to create fantastic prospective standards, adherence to them would present a much greater problem. Since tough standards slow down the meeting of plan targets, Gorbachev's predecessors "looked at the violations through their fingers." To combat the widespread abuse of the standards, he made the most logical decision within the existing system, i.e., to apply the experience of military controllers (*voenpredy*) to civilian production. In 1987 a state quality control system supervised by *Gosstandart* will be introduced at many important firms. In addition to the controllers being independent of firm's management, their wages will also be independent of the firm's meeting the plan targets, except for those for goods quality. Although a limited experiment with state quality control was going on since 1985, and the idea is generally healthy, it is not clear whether the controllers could go beyond enforcing the existing standards. It is, however, clear that the introduction of state quality control as well as the expansion of state product certification are geared toward further centralization of decision making in the Soviet economy.

5. Conclusion

Three aspects of Gorbachev's modernization program—technological change, investment priorities, and product quality improvements—have been considered in this paper. His program ties all of these together into a harmonious set of developments, at the heart of which is the increase in the economic efficiency of Soviet production capital stock. Rapid innovation and the introduction of advanced machines are his ways of raising efficiency. The program

[39] V Tsentral'nom Komitete KPSS i Sovete Ministrov SSSR, Ekonomicheskaia Gazeta 28, Jul. 1986:4.

will supposedly have two chief impacts: firstly, material inputs currently wasted will increasingly be saved with the use of new technologies and sophisticated machines, and, secondly, the currently poor quality of manufactured goods will improve dramatically.

Although Gorbachev blames his predecessors for neglecting technological policies, the three industrial branches that the Soviets view as the key to the efficiency for all of the economy—the MBMW sector, chemical production and electric power—have been at the top of Soviet priorities for the last 25 years. The policies suggested by Gorbachev are not new, and similar attempts have failed in the past. So it is natural to question their feasibility now. The whole drive is based upon the intent of more than doubling the replacement rates for equipment by accelerating the production of new machines and by reorienting the investment process from new construction to the renovation of existing plants. But, as our calculations show, the projected growth of the MBMW sector will let the replacement rates rise by barely one percentage point from the current 2.5 percent rate by 1990. Greater growth for the MBMW sector would be impossible because of constraints imposed by metal production. Moreover, shortages of raw materials will force the Soviets to siphon additional investment from the renovation process into new construction, and relevant corrections will be made in the annual plans. (Annual corrections usually prevent the Soviet economy from advancing according to five-year projections. On the other hand, these corrections play a stabilizing role, for they reduce the impact of shocks caused by sharp swings in the leaders' directives).

If the feasibility of the renovation process *per se* is doubtful, even more doubtful is its impact on the Soviet economy. According to the Soviet press, so far there has been no strong correlation between the installation of new machines and product quality improvement. This is understandable, since having better machines is not the only factor in advancing the qualities and quantities of manufactured goods. A good example is the use of numerically controlled machine tools. There were high expectations from such machines in the 1960s, but, as more and more of those machines were introduced, publications appeared in Soviet press condemning the wasteful way they were used. The early retirement of machines may lead to underemployment of production capital. This is not to say that longer use of obsolete equipment is better, but the imposition of higher mandatory retirement rates will augment waste on the part of plant management. Another threat is that the new and more costly equipment will be underutilized to an even greater extent. The Soviets want unique, expensive machines to be used during three shifts whereas, in many instances, they are not fully used even during the first shift. Two factors will make the problem of underutilization worse—the shortage of labor and the shortage of raw materials. Even if the labor shortage can be relieved by changes in wage and employment policies, shortages of metals and agricultural raw materials will remain as stumbling blocks.

Where will they get additional inputs for the renovation program? Since there are no reserves, these inputs will become available to the MBMW sector only at the expense of other industries. In 1984 I wrote elsewhere that the Soviet economic experiment ini-

tiated then would be successful only as long as a very small number of ministries were involved, since their supplies could be provided by undersupplying other ministries. But, when more ministries got involved (according to the July 1985 resolution, by 1987), the effects would peter out, and the *status quo* would be restored.[40] At one of the discussions on the broadening of the experiment, a Soviet plant manager now raises the same question: "The problems of supply will undoubtedly be the cornerstone not only for the experiment, but for the entire 12th five-year plan. If they are positively solved for a limited number of firms participating in the experiment, it is necessary to think of what will happen if all firms switch to the new system." [41] The traditional Soviet system of priorities will answer the question. For instance, if additional inputs are channeled into the MBMW sector, what industries are to suffer most? Since lower supplies may jeopardize the renovation process, as well as other important programs, the authorities will minimize the possible slowdowns in the production of raw materials. Sherlock Holmes' deduction method then leaves us no choice but the consumer goods sector. It is always the consumer goods sector whose revival is sincerely promised but postponed, for new machines, or metals or oil are urgently needed.

Along with the costs, there must also be benefits from the modernization program. After all, every cloud has its silver lining. In the MBMW sector, investment will rise 1.8 times, and the growth rates will be 1.7 times those for the industry as a whole. Thus the MBMW sector will be a distinct beneficiary. Doubtless, the efficiency of some machines will increase, and, as a result, there will be improvements in the industries for which those machines are designated. But, as is typical in the Soviet case, advances will be limited to the specifically targeted branches or technologies. The experience of other, similar programs, such as electrification or chemicalization, is a good illustration. As a result of huge investments, electric power and chemical production advanced significantly, with some impact on the Soviet economy. Yet the projected effects of those programs—the elimination of manual jobs by the use of electrical machines and the massive substitution of metals and other natural raw materials by synthetics—did not materialize.

On the surface, there seems to be widespread support for Gorbachev's modernization program. Along with white collar workers in the military industrial complex, research and project institutes were enthusiastic about new and interesting projects, until the threat of liquidation has become real for some of them. The situation is also mixed in other industries. On the one hand, managers and engineers there support the idea of modernization. On the other hand, since the program will impose much heavier burdens on industries producing raw materials and, most importantly, the construction industry, the same managers and engineers feel unhappy about the prospects of being held responsible for failing to reach unrealistic goals. Mixed feelings also exist among economic bureaucrats, simplistically portrayed as sabotaging Gorbachev's ini-

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[40] Kushnirsky, F.I., The Limits of Soviet Economic Reform, *Problems of Communism*, Jul.-Aug., 1984:42–43.

[41] Chuprin, E.I., Comments in "Prava, ogranicheniia, perspektivy," *EKO* 11, 1985:64.

tiatives. Since technological modernization drains resources from other programs, in the past they knew that priority had to be given to the production targets. Presently, however, they must meet conflicting requirements for both accelerated economic growth and intensive modernization, and all of that with much lower supplies of material inputs. Finally, Soviet blue collar workers, unhappy about the antialcohol campaign, by and large remain indifferent to the modernization drive.

In sum, Gorbachev's modernization program is not consistent with a reform approach. It is highly contradictory: he wants to have entrepreneurship without entrepreneurs, thriftiness in production without personal financial liability, and high product quality without market competition. The program can, however, have potentially interesting consequences when Gorbachev becomes disappointed with its outcome. Two distinct possibilities will be open to him; he can declare every failure a success, as Brezhnev did since the mid-1970s, or he can look for alternative solutions. The available evidence suggests that he would prefer to avoid the first option. Yet, as time runs out and the number of commitments Gorbachev makes rises, it will become increasingly difficult for him to disassociate himself from the "mistakes of the past" and to change course. The fact that Gorbachev is aware of such a pitfall and is determined to keep all doors open explains the diversity and contradictions of his economic initiatives. Along with the modernization drive, notable are limited self-financing for industrial ministries and their greater autonomy is foreign trade operations, small-scale joint ventures, stiffer prosecution of "unearned income," legalization of certain private services and consumer goods manufacturing, and the enhancement of the economy's cooperative sector. At this point, however, it is not clear whether current experimentation is merely a patchwork or a beginning of a cautious revision of the Soviet economic model.

THE SOVIET CONSTRUCTION MATERIALS INDUSTRY: ITS ROLE IN ECONOMIC EXPANSION

By Christopher P. Pedersen*

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I. Summary

Mikhail Gorbachev's aggressive modernization program will challenge the construction materials industry to supply more and better quality products for renovating and expanding production facilities. In addition, his program to improve consumer welfare depends, in part, on more and better housing. Whether the industry can meet these challenges depends on its ability to overcome a number of problems that have contributed to its deterioration performance over the past decade.

Growth in the production of construction materials slowed abruptly between 1975 and 1982, when output rose on the average by only 1.1 percent annually. Factors contributing to slow production growth included the deteriorating quality and shortage of raw materials, aging plant and equipment, inadequate investment, shortages of labor, irregular supplies of energy, and transportation bottlenecks. These deficiencies were exacerbated by the fragmentation of administrative responsibility for the planning, production, and distribution of construction materials. Performance improved

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slightly during 1983–85, because of increases in industrial capacity and labor productivity. Growth, however, is still well below the rates necessary to assure an adequate supply of materials to meet investment plans for the balance of the decade.

Many of the factors that contributed to poor performance in 1976–82 are deeply rooted in the system. If Gorbachev's modernization program is to succeed, increased attention to the industry's problems is in order. The General Secretary obviously hopes that deemphasizing new plant construction and vigorous action to conserve construction materials will reduce the growth in demand for these products. He must, however, deal with two immediate problems: the inefficiency of construction materials production and the past inefficient allocation of investment to the industry. Gorbachev took a major step toward addressing the first problem by appointing Sergey F. Voyenushkin—a critic of current construction practices and an established innovator—as Minister of the Construction Materials Industry in July 1985.

Gorbachev will be hard pressed to reconcile his concomitant needs to boost investment in machine building, meet the investment needs of energy and agriculture, and increase investment in the construction materials industry. On the demand side, he will find it difficult to deemphasize new construction as such as he would like and to otherwise get the economywide construction materials conservation he is counting on. Therefore, unless investment is increased substantially to develop new sources of raw materials, commission new production capacity, renovate old plants, and increase output of processing equipment, continuing construction materials shortfalls will seriously hamper Gorbachev's modernization and consumer welfare efforts. Specifically, new housing starts will slow, capital renovation will be delayed, and the planned increases in the production of advanced and higher quality construction materials will not be realized.

II. The Setting

The efficiency of the national economy and the rates of our growth depend to a great extent on the structure and quality of materials. At present we are lagging in this task.—Mikhail S. Gorbachev, at the June 1985 Science, and Technology Conference.

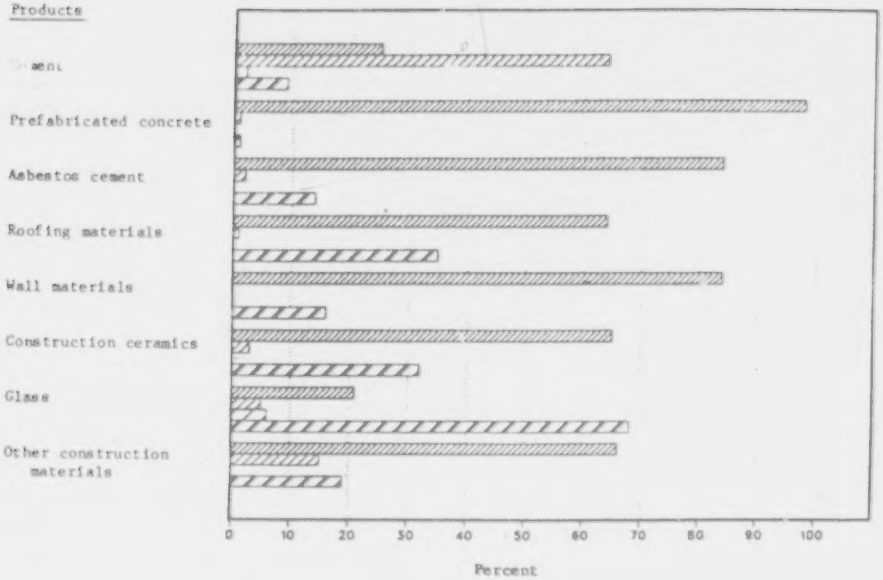
Since coming to power, Mikhail Gorbachev has set in motion the most aggressive economic agenda in the USSR since the mid-1960s. His initiatives are aimed at raising productivity and efficiency throughout the economy by matching more and better equipment with a motivated work force. Although Soviet economic performance has improved in recent years from the low levels of 1979–82, accelerated growth is required if targets are to be met.

One of the constraints to growth is inadequate investment for economic modernization and expansion. Renovating and reequipping existing enterprises rather than building new ones is a key element of Gorbachev's modernization strategy. Unless more resources are allotted to expansion of the construction materials industry, however, the goals for modernization and renovation of industrial facilities will not be achieved.

The General Secretary has stated that construction is the main support mechanism that will facilitate economic expansion. To maintain an effective construction sector, the construction materials industry must provide more and better quality materials, particularly cement, concrete, wall materials (especially gypsum), and ceramic products. About two-thirds of the total output of construction materials is used in domestic construction—both civilian and military. Construction is the largest consumer of cement, prefabricated concrete products, lumber, glass, bricks, and structural metal elements (see figure 1).

Figure 1

USSR: Estimated Disposition of Output From the Construction Materials Industry, 1982



Legend
- Domestic construction
- Construction materials industry
- Exports
- Other sectors of the economy

The various sectors of the construction materials industry are closely linked, with poor performance in one affecting the others. The key sector is cement, which "sells" over 60 percent of its product to six of the remaining sectors. Slow growth in cement supplies, for example, has constrained the production of prefabricated concrete, a major ingredient in construction.

THE SOVIET CONSTRUCTION MATERIALS INDUSTRY

The USSR Ministry of the Construction Materials Industry includes more than 300 production associations, enterprises, and organizations at the national level as well as 15 republic ministries. The all-union ministry is organized into seven general divisions—Administration, Industry, Economy, Science and Technology, Supply and Repair, Workers, and Miscellaneous—each of which contains several departments and administrations.

The Industry and Economy divisions are of primary importance because they coordinate planning and production targets with the State Planning Committee. Most of the other divisions provide contributions to the Economy Division when their efforts may affect plans and targets. The Economy Division measures performance and provides guidance when deviations from plans occur. The Industry Division is involved most heavily with the use of resources needed for material production and distribution. It contains the departments responsible for the eight product sectors of the industry—cement, prefabricated concrete, asbestos cement, wall materials, roofing materials, construction ceramics, glass, and other construction materials.

Although the industry processes many varied products that have uses in all sectors of the Soviet economy, output of the construction materials industry constitutes only 5 to 6 percent of total Soviet industrial production.

III. A Troubled Industry

Rapid increases in the output of construction materials in the 1961–75 period—up by an average of 5.5 percent per year—were followed by an abrupt slowdown in growth to only 1.5 percent annually in the last half of the Seventies. Since 1980, performance in the industry has been mixed: production virtually stagnated in 1981–82 but made a moderate recovery in 1983–84. The severe winter hampered output in the first quarter of 1985; by the end of the year, however, the industry had rebounded and posted growth of 1.5 percent for the year as a whole, a level similar to that recorded for 1984 (see tables 1 and 2). [1] Overall rates of growth in the output of construction materials, however, were less than half those originally targeted for 1981–85.

[1] Performance in the precast ferroconcrete sector was so abysmal that the Soviets withheld monthly production statistics for three consecutive months early in 1985.

TABLE 1.—USSR: AVERAGE ANNUAL GROWTH OF CONSTRUCTION MATERIALS OUTPUT

[In percent]

	1961-75	1976-80	1981	1982	1983	1984	1985
Total	5.6	1.4	1.5	−0.9	3.5	1.7	1.5
Cement	7.8	0.6	1.8	2.9	3.8	1.5	0.2
Prefabricated concrete	9.5	1.3	2.0	−0.9	3.8	3.2	3.2
Wall materials	2.2	−1.6	0.4	−0.3	2.6	−0.5	−0.1
Asbestos cement	6.6	−1.4	2.0	1.5	4.1	2.8	2.2
Roofing materials	5.9	−0.4	−0.8	−0.4	7.9	2.4	2.3
Construction ceramics	6.1	2.5	8.7	5.8	4.9	2.5	2.7
Glass	5.2	2.0	−1.1	0.5	3.5	0.4	−0.7
Other construction materials [1]	4.9	3.8	1.5	−2.0	3.3	1.7	1.2

[1] Includes construction lime, gypsum, rock products, and mineral wool insulation.

Source: CIA's index of Soviet industrial production.

TABLE 2.—USSR: PRODUCTION OF MAJOR CONSTRUCTION MATERIALS

	1975	1980	1981	1982	1983	1984	1985
Cement (million tons)	122.1	125.0	127.2	123.7	128.2	129.9	131.0
Precast ferroconcrete (million m^3)	114.2	122.2	124.5	123.6	128.3	132.4	137.0
Prestressed reinforced concrete	27.2	27.2	28.1	27.6	28.5	29.4	29.6
Asbestos cement (billion tiles)	7.8	7.3	7.5	7.6	7.9	8.1	8.3
Wall materials (billion bricks)	63.0	58.0	58.3	58.1	59.6	59.2	59.1
Construction bricks	47.2	41.8	41.8	41.6	42.5	41.8	41.2
Refractory brick	33.7	27.5	27.4	27.1	27.6	27.1	26.6
Soft roofing materials (million m^2)	1.8	1.7	1.7	1.7	1.8	1.9	1.9
Roofing tile (million m^2)	1.9	0.6	0.6	0.6	0.7	0.7	0.6
Linoleum (million m^2)	71.9	93.1	95.1	96.2	99.9	106.0	113.0
Ceramic floor tiles (million m^2)	23.7	23.2	26.0	27.6	29.5	30.3	30.9
Styled ceramic wall tiles (million m^2)	24.1	32.6	35.4	37.5	39.3	40.4	41.8
Acid-proof ceramics (thousand tons)	601.0	609.0	605.0	601.0	616.0	612.0	606.0
Sanitary ceramics (million units)	8.9	9.6	9.7	9.7	9.9	10.0	10.0
Window glass (million m^2)	269.0	245.0	245.0	243.0	247.0	247.0	243.0

Source: Narodnoye khozyaystvo SSSR, various years (hereafter referred to as Narkhoz).

Most of the poor performance of the industry since the mid-1970s is due to the substantial decline in both the growth of capital and labor inputs and their productivity (see table 3). Many factors contributed to this decline.

TABLE 3.—USSR: AVERAGE ANNUAL GROWTH OF PRODUCTIVITY ON THE CONSTRUCTION MATERIALS INDUSTRY

[In percent]

	1961-65	1966-70	1971-75	1976-80	1981	1982	1983	1984	1985
Combined productivity [1]	−1.4	0.4	−0.2	−2.3	−1.0	−3.9	0.1	−0.7	−0.8
Capital	−7.5	−1.9	−4.1	−5.2	−3.4	−5.5	−2.4	−3.0	−3.3
Labor	4.9	2.7	3.7	0.5	1.4	−2.3	2.6	1.5	1.7

[1] Combined productivity is calculated using a Cobb-Douglas production function. Inputs of capital and labor are weighted with their respective income shares in 1982, estimated in the derivation of GNP at factor cost in that year. Labor is assigned 51 percent and capital 49 percent.

A. DETERIORATING QUALITY AND SHORTAGES OF RAW MATERIALS

The quality of quarry products, such as limestone and gypsum, has been deteriorating because of increasing reliance on the exploitation of marginal deposits. Soviet use of lower quality raw materials increases both production problems and costs. For example, according to one Soviet study, up to one-third of the decline in cement production in 1979 resulted from difficulties in processing low-quality raw materials.

Chemical additives—essential for building materials exposed to extreme cold—as well as steel reinforcing material and crushed stone are in short supply. Shortages of stone have caused concrete plants in some construction administrations to operate at as little as one-fifth of capacity in recent years. Although industrial byproducts, such as blast furnace slag, nonferrous wastes, and fly ash can compensate for inadequate supplies of some raw materials, annual increases in the availability of these substitutes have fallen off with the drop in growth rates of the metals and coal industries.

B. PROBLEMS WITH CAPITAL EQUIPMENT

The Soviets have added little new capacity in the construction materials industry since 1980 and, according to a plethora of Soviet press reports, much new equipment operates far below rated capacity. Moreover, the majority of the capital equipment currently in use is over 20 years old. The amount of repair work has consequently skyrocketed with shutdowns for repair—exacerbated by shortages of labor and materials—taking a significant toll on production and efficiency. Because of the limited additions to plant and equipment, Moscow—despite the growth of the pool of skilled repair workers—has been unable to compensate for this loss.

C. INADEQUATE INVESTMENT

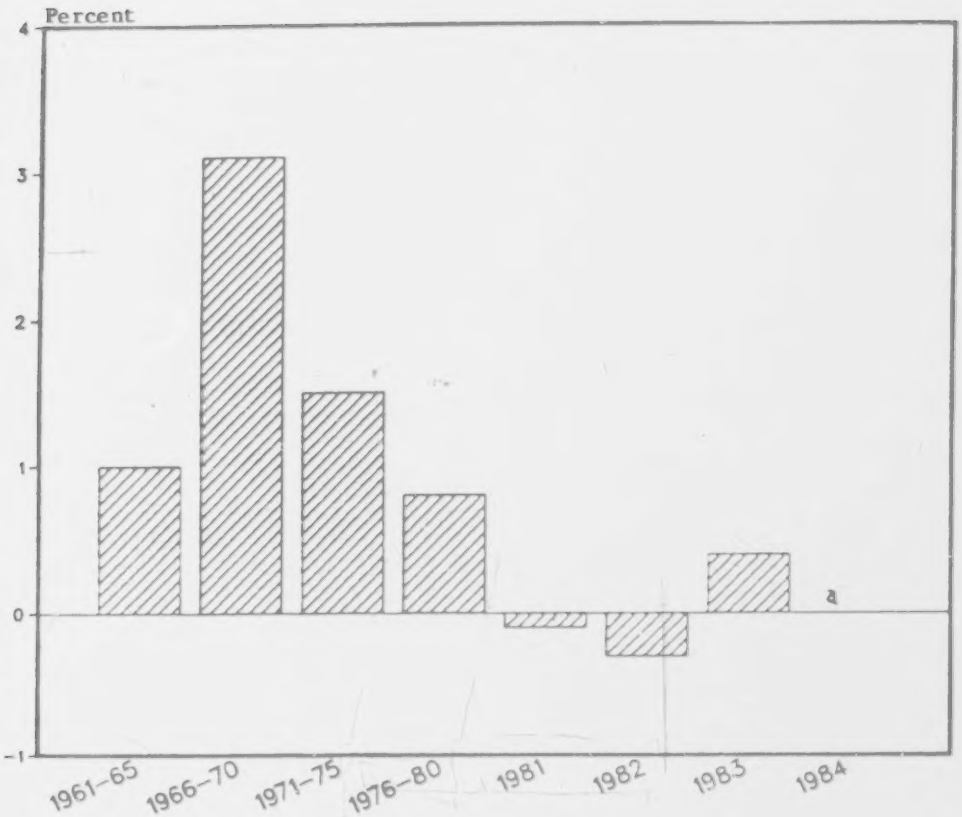
During 1971-75, the construction materials industry's share of total industrial investment was 5.5 percent. By 1985, its share had declined to 3.5 percent, reflecting the higher priority accorded to other branches of the economy. Moreover, the investment that has been dedicated to the construction materials industry, as in some other branches of industry, has been skewed toward the construction of finished product capacity to the relative neglect of developing raw materials, storage facilities, and social infrastructure such as worker housing.

D. SHORTAGES OF LABOR

In line with a general decline in the growth of the Soviet labor force, growth of employment in the construction materials industry has fallen since the early 1970s, with zero growth recorded in 1984 (see figure 2). This as resulted in an acute shortage of skilled labor across the entire industry. A large, continual turnover of labor because of inadequate investment in social infrastructure has exacerbated the problem. According to a Soviet industry expert, the share of such investment in the cement industry alone would have to be almost doubled to prevent excessive labor turnover.

Figure 2

USSR: Average Annual Growth of Employment in the Construction Materials Industry, 1961-84

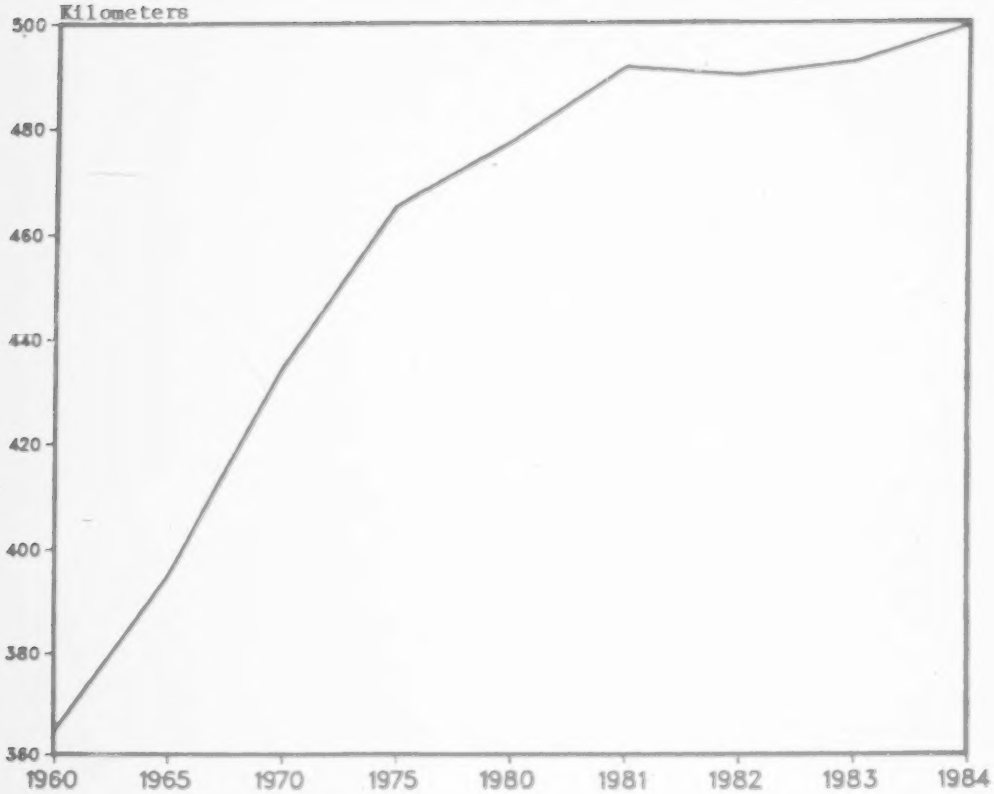


[a] Zero or no growth

Source: Narkhoz, various years.

Figure 3

USSR: Average Length of Haul by Rail for Construction Materials, 1960-84



Source: Narkhoz, various years.

E. IRREGULAR SUPPLIES OF FUEL AND ELECTRICITY

The construction materials industry is heavily dependent upon electricity and gas, and interruptions in the supply of energy have pushed down production of construction materials. Since the late 1960s, the industry has attempted to reduce its reliance on coal by replacing it with gas, which is both more efficient and reliable. Limited gas storage facilities and distribution lines, however, have prevented a faster transition.

F. TRANSPORTATION BOTTLENECKS

Bottlenecks in transportation—especially in 1979, 1982, and 1985—have also restricted output. The siting of many construction materials plants near raw material deposite has necessitated the transportation of building products over increasingly longer distances (see figure 3). As a result, Moscow has to cope with rising shipping losses due to theft and spillage along the route. Ironically, many of these same construction materials plants have exhausted the supply of raw materials at nearby quarries. As a result, heavy and bulky materials must be brought in from elsewhere, adding to the transportation system's already heavy burden.

G. FRAGMENTATION OF ADMINISTRATIVE RESPONSIBILITY

Administrative responsibility for the planning, production, and distribution of construction materials is divided among a myriad of organizations. The Ministry of the Construction Materials Industry is nominally tasked with these duties, but at least sixteen other ministries, committees, and directorates are identified with material-related responsibilities. For example, the Ministry of Ferrous Metallurgy produces the blast furnace slag to be used in slag bricks; the Ministry of Construction in the Northern and Western Regions produces concrete for civilian construction projects; the Main Directorate for Special Construction produces concrete for military construction projects; and the Ministry of the Chemical Industry produces and distributes polymeric materials and phosphogypsum. This division of responsibility exacerbates poor performance caused by the other factors noted above.

IV. Impact of Poor Performance

The poor performance of the construction materials industry, along with excessive waste in Soviet use of construction materials, has had a substantial negative impact throughout the economy. Many different industries as well as specific geographical areas have been affected. Although 1979 and 1982 were particularly bad years, shortages of construction materials have occurred consistently since the mid-1970s and have continued to affect Soviet enterprises in 1985 (see table 4).

TABLE 4.—USSR: SELECTED PRODUCTION SHUTDOWNS AND WORK STOPPAGES DUE TO CONSTRUCTION MATERIALS SHORTAGES, 1985

Date	Facility	Cause	Effect
January 1985	Nikol'skoye facility	Building brick shortage	Hampered construction for indeterminate period.
February 1985	Millerovo Metallurgical Equipment Plant	Construction material shortage	Construction delayed for indeterminate period.
March 1985	Talasskiy Brick Plant	do	Plant reconstruction delayed; quarter plan 20 percent fulfilled.
April 1985	Karatav Chemical Plant	do	Construction delayed for indeterminate period.
June 1985	Chardzhou Chemical Plant	do	Half-year construction plan unfulfilled.
June 1985	Saratov Region	Roofing material shortage	Delayed rural construction.
July 1985	Baku Concrete Trust	Construction material shortage	Idled plant up to five days.
July 1985	Krasnoyarsk Heavy Excavator Plant.	do	Delayed construction plans by over one year.
August 1985	Latvia construction groups	do	Private construction delayed.
September 1985	Novolipetsk Metallurgical Combine.	Cement shortage	Paralyzed facility construction.
September 1985	Podolsk Experimental Cement Plant.	Construction material shortage	Slowed cement production.
September 1985	Tula Oblast'	do	Nine-month housing plan 73 percent fulfilled.

A variety of Soviet enterprises faced shortages of clinker and slag, glass, gypsum, refractory bricks, and slate during the year, resulting in construction being delayed, plants shutting down, and workers being laid off. Appeals to the State Committee for Material and Technical Supply (Gossnab) and the Central Committee of the CPSU have resulted only in the issuance of decrees calling for additional production from enterprises of the Ministry of the Construction Materials Induustry and increased availability of rail transport.

V. Past Attempts to Address the Problem

The Central Committee supports the ideas expressed at the June Science and Technology Conference on the need for . . . the production of efficient construction materials.—Mikhail S. Gorbachev, at Tyumen' in September 1985.

Senior Soviet officials have long been aware of the problems confronting the construction materials industry. As long ago as 1972, they recommended alleviating these problems largely by developing additional capacity, expanding automation, and instituting an economywide effort to conserve on the use of construction materials. However, these exhortations were not backed by sufficient investment throughout the Seventies. Since 1980, there has been little addition to the industry's capacity. Moreover, the limited success in automation has been unable to improve the quality of materials produced and reduce the labor intensiveness of the industry. The impact of these constraints has been magnified by Moscow's inability to move ahead smartly on eliminating waste in the use of construction materials and in reducing the material intensiveness of construction. As a result, Moscow has had to increasingly rely on imports to reduce the ensuing shortfalls.

A. NEW CAPACITY

To meet growing demand in the late 1960s and early 1970s, the Soviets expanded production of construction materials. By the late 1970s, however, this was no longer possible. Labor shortages hampered production, and investment allocations dwindled. The building of new construction materials enterprises was cut back so that, by 1981 and 1982, commissioning of new capacity was virtually nonexistent. Even though the industry was recognized by the leadership as important for economic expansion, it was not until late 1983 that this importance was translated into the commissioning of new capacity. In 1984, a considerable amount of new capacity was added, but new commissionings were still well below levels of the early 1970s (see table 5).

TABLE 5.—USSR: COMMISSIONING OF NEW CAPACITY IN THE CONSTRUCTION MATERIALS INDUSTRY [1]

[Million units]

	1966–70 [2]	1971–75 [2]	1976–80 [2]	1981	1982	1983	1984	1985
Cement (tons)	3.5	4.1	2.2	0	1.8	0.3	1.8	1.9
Asbestos cement shingles (tiles)	272.4	252.8	119.4	113.0	0	32.0	66.0	0
Precast ferroconcrete (tons)	4.8	5.9	5.1	5.0	4.3	5.3	5.0	3.2
Window glass (m^2)	5.5	6.9	5.0	0	0	0	7.3	8.0

[1] These figures include capacity originating in new construction and in expansion of existing plants.
[2] Annual averages.

Source: Narkhoz various years.

B. AUTOMATION

With the decline in the growth of the labor pool and slow additions to new capacity, the Soviets began to look to automation as a means of expanding production through the substitution of machinery for labor. In addition, automation was seen as a way of assuring uniform product quality. Problems frequently arose, however, especially in the design of new plants. Enterprises were usually designed without detailed investigation of the specific types of equipment to be used or whether the equipment was to be fully automated, semiautomated, or not automated at all. As a result, additions to new capacity were often delayed.

To correct these problems, the All-Union Scientific Research and Planning-Design Institute for the Automation of Construction Materials Industry Enterprises developed three types of automated systems: the automated control system of production processes concerned with accounting, planning, and optimizing production resources, especially applicable in the area of inventory control; the automated control system for technological processes for automation of conveyor-type production lines (not robotics, but rather computer-assisted automated control systems); and the automated technological complex designed to control all plant production operations.

The introduction of this new technology, however, is being held back by the Soviet system's bureaucratic inefficiencies and lack of appropriate incentives. Plant managers, for example, are reluctant

to try any new production techniques since the time needed to install a new system, train workers in its operation, and then discover and correct defects substantially hinders the plant's ability to produce planned output. Management is also opposed to computerized inventory control, since it would reveal resource stockpiles used to ensure fulfillment of a subsequent plan, decrease the manager's "cheat margin," and lower the plant's chances to fulfill its production plan and the workers' chances to receive bonuses. Gorbachev may be hoping that some restructuring of the incentive system and performance indicators will overcome management's opposition to automation.

C. CONSERVING ON THE USE OF CONSTRUCTION MATERIALS

Moscow obviously hoped that a successful economywide conservation effort would reduce the growth in demand for construction materials and thus allow the industry to get by with reduced investment. Although lipservice was paid to conservation as early as the Ninth Five-Year Plan (1971–75), it was not until the 1981–85 Plan that the conservation drive picked up momentum. Between 1980 and 1984, the Soviets adopted several resolutions, held conferences, and implemented programs in an effort to conserve.

Two resolutions of the CPSU Central Committee in 1981 set forth both the problems necessitating conservation and ways to solve the problems. These resolutions were followed by an April 1982 All-Union Conference on the Conservation of Material Resources held in Moscow. This conference led directly to the November 1982 plenum of the CPSU Central Committee, which drew attention to the necessity for improving construction efficiency through measures for reducing the expenditure of fuel, raw materials, metal, and other products, as well as financial and labor resources.

In 1983, specific recommendations were adopted in a CPSU Central Committee resolution, which the construction materials industry coalesced into a three-pronged conservation strategy, including:

- —The preferential manufacture of products that facilitate a decrease in the weight of buildings and structures and an increase in their heat insulation.
- —The accelerated development and introduction of energy-saving technologies in the production of cement, ceramic products, glass, lime, and reinforced concrete.
- —The conservation of raw materials within the construction materials industry through a reduction in the material intensiveness of manufactured products and maximum utilization of secondary resources, including wastes of other sectors of the economy.

Although the Soviets have implementd numerous conservation programs, there are still relatively large losses of material resources. Resolutions, conferences, and decrees—the traditional cure-alls of the Soviet bureaucracy—have had relatively little impact. Given the shortage of building materials, construction crews cannot make up for the material supplies they have either failed to receive initially or wasted in the process of construction. Inefficient shipment and use of construction materials along with inadequate storage facilities which lead to spoilage have thus con-

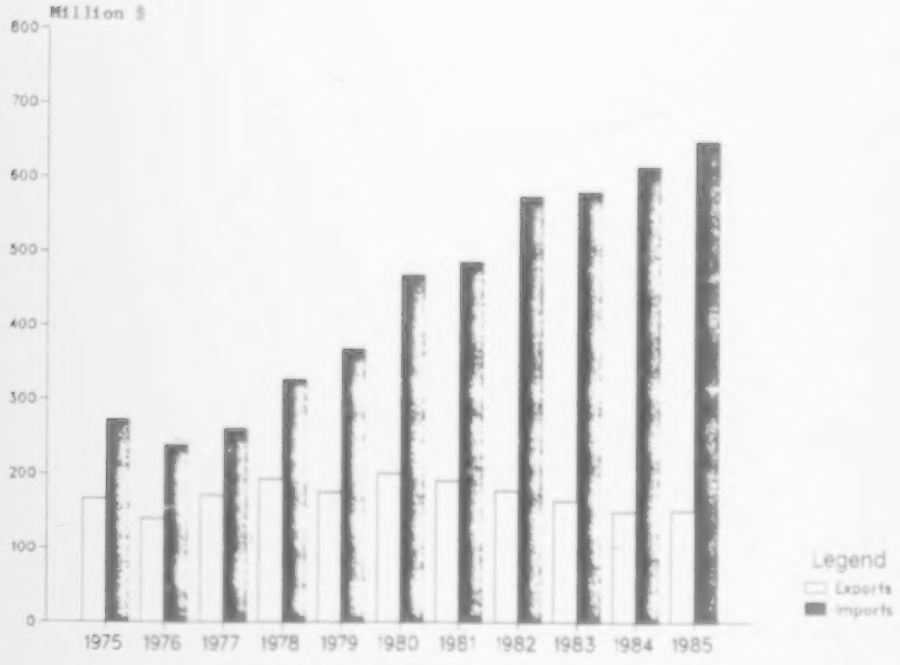
tributed to the high value of unfinished construction, which in 1984 amounted to 78 percent of annual investment for the Soviet economy as a whole, and 87 percent of investment for the construction materials industry. As a result of the continuing shortages, what little investment the industry received had to go toward increased capacity for basic rather than advanced, higher quality construction materials.

D. FOREIGN TRADE

With lagging domestic output, the Soviet Union has been forced to increase imports of construction materials, especially since the mid-1970s (see figure 4). Soviet construciton material imports are concentrated in the areas of insulation materials, linoleum, refractories, and wall materials. The value of insulation and wall material imports—$400 million in 1985—reflects the expansion of Soviet housing, especially in the Far East, far north, and the densely populated southern and southwestern portions of the country. The large value of refractory imports highlights continued problems in the cement sector and the steel industry. In 1985, imports of refractory materials totaled $114 million or three-fourths of Soviet domestic requirements.

Figure 4

USSR: Trade in Construction Materials, 1975-85



Source: Vneshnyaya torgovlya v SSSR, various years.

Since the mid-1970s, purchases from the Developed West have constituted approximately one-third of all construction material imports. A large share of imports—60 percent—comes from Eastern Europe and North Korea. In 1985–86, the Soviets were scheduled to import cement from Ethiopia, North Korea, and Poland and insulation materials from CEMA countries. The Soviet Union imports insulation materials from the United States, Italy, and Japan and buys refractory materials from France. The United Kingdom supplies a variety of materials. Overall, hard currency imports of construction materials totaled $175 million in 1985.

VI. Looking Ahead

The proportion of plastic materials, ceramics, and other advanced nonmetallic materials is still small in the overall volume of materials. We must exploit highly effective scientific and technological research developments, such as . . . highly effective types of polymer materials.—Mikhail S. Gorbachev, at the June 1985 Science and Technology Conference.

Although automation and conservation efforts have contributed somewhat to improved performance in recent years, the industry still has a long way to go. Gorbachev's emphasis on advanced materials in his economic agenda means that further action will have to be taken soon. Commissioning of new capacity during the 12th Five-Year Plan (1986–90) probably will remain relatively low given Gorbachev's emphasis on the machine-building sector and the substantial material savings in construction materials envisioned from renovating existing facilities. Although Gorbachev recognizes the need to reduce shortages of construction materials, he probably hopes that his emphasis on renovation as opposed to new plant construction, along with an intensive, economy-wide campaign to conserve on constuction materials use, will allow him to hold down the share of investment to the industry.

He has also addressed problems within the industry itself. In his 11 June 1985 address to the Conference on Science and Technology, Gorbachev chided the construction sector and the construction materials industry for the vast amount of unfinished construction. He emphasized the need to focus future work on plant modernization, a theme that has since been echoed in *Pravda* editorials. Whether he will be able to reduce demand is problematic. In any event, some new construction will be necessary to bring down the high level of unfinished construction in the industry and to add new facilities dedicated to the production of new, better quality construction materials that will be demanded by the construction sector, such as basalt plastics, glass ceramics, and polymeric materials.

Two major problems that thus require immediate attention are the inefficiency of construction materials production and the past insufficient allocation of investment to the industry. Gorbachev has taken a major step toward addressing the first problem; he selected a new Minister of the Construction Materials Industry, Sergey F. Voyenushkin, in July 1985. Voyenushkin was elevated from the post of RSFSR Minister of the Construction Materials Industry. The new minister has openly criticized the current system and has an established record of innovation. He is not in a position to address the fragmentation issue, however.

SERGEY FEDOROVICH VOYENUSHKIN

Age: 58

Member of the Communist Party since 1951

Graduate of the Karelian-Finnish State University

(Candidate of Economic Sciences)

Voyenushkin has been in the construction materials industry since 1958 and has held a variety of increasingly responsible posts:

1958–65—Deputy chief, then chief of the Administration of the Construction Materials Industry on the Karelian and Northwest National Economic Councils

1965–70—Deputy chief, then chief of the construction materials industry's Main Administration of the Nonmetallic Ores Industry

1970–75—Chief of the Planning and Economic Administration, USSR Ministry of the Construction Materials Industry

1975–79—First Deputy Minister of the RSFSR Ministry of the Construction Materials Industry

1979–85—Minister of the RSFSR Ministry of the Construction Materials Industry

1985–present—Minister of the Construction Materials Industry.

Voyenushkin has published numerous articles in the Soviet press and technical journals, many of which reveal his innovative tendencies:

—"Computed Net Production as an Index of Economic Activity of an Enterprise" (*Voprosy ekonomiki*, Dec 1976)

—"Construction in the RSFSR" (*Pravda*, 7 Jan 1978)

—"Effective Management of the Economy and its Aspects in the Construction Materials Industry" (*Pravda*, 16 Apr 1979)

—Discussion of the RSFSR State Plan and Budget for 1981 (*Leninskoye znamya*, 21 Nov 1980)

—"Subsidiary Enterprises Advanced; Developmental Problems Noted" (*Sovetskaya rossiya*, 4 Jun 1982)

—"Development of the Glass and Ceramic Industries" (*Steklo i keramika*, Jun 1982)

In his former position as RSFSR Minister of the Construction Materials Industry, Voyenushkin has demonstrated a willingness to deal with problems:

—He dismissed personnel in a construction plant for failure to meet construction deadlines and schedules in 1982.

—He dismissed personnel at another facility in connection with complaints of defective equipment in 1983.

—Under his leadership, the ministry exceeded plan targets for increased labor productivity and cost reductions in 1984.

A. SHORT-TERM INDICATORS

With the release of goals for the 1986–90 Five-Year Plan, we have some understanding of what the industry will be tasked with over the next five years, but little knowledge yet of the flow of investment to underwrite these tasks. Over the next year or so, indications that Moscow is moving aggressively to improve the performance of the construction materials industry would include:

—An increase in the investment allocated to the industry in the 1986–90 Five-Year Plan.

—Moves by Voyenushkin to replace ineffective managers throughout the industry as he did in the RSFSR.

—The widespread application of a system to ensure delivery of materials to construction sites in complete sets. This would alleviate excessive amounts of material supplies at construction sites, reduce losses of materials, and avoid work disruptions caused by inadequate supplies of specific materials.

—The formation of a new construction committee, encompassing the material-related responsibilities of the sixteen organizations currently having such responsibilities.
—The signing of major contracts with Western firms for the renovation of construction materials plants which could lead to modernization of a large portion of the industry and appear to be a high priority even with hard currency constraints.

B. LONG-TERM REQUIREMENTS

Areas that will require long-term attention include completion of unfinished construction within the construction materials industry and improvement of the system of reports and monitoring controls over the expenditure of material resources. Increased materials conservation and expanded automation will also be necessary.

Conservation in the general economy will make a long-term contribution by releasing scarce types of primary raw materials and supplies, increasing material resources, and reducing pollution of the environment by waste products. Specific measures probably will include the assignment of specific tasks for saving material resources both for the five-year plan and each individual year, the expansion of the production and introduction of lightweight structural elements and materials with high tensile strength, and the increased utilization of industrial waste products.

Accelerated automation is a key to continuing growth of the construction materials industry and could lead to a substantial increase in the efficiency of production: higher productivity of labor, greater and more uniform output, and reduced consumption of energy and raw materials. This will require a number of expensive measures over the long term, especially the mechanization and automation of basic and auxiliary production processes through the widespread introduction of computers.

C. PERSPECTIVES

Gorbachev will be hard-pressed to reconcile his needs to boost investment in machine building, meet the investment needs of energy and agriculture, and increase investment in the construction materials industry. He will also find it difficult to deemphasize new construction as much as he would like and get the economywide conservation he is counting on.

If investment in construction materials is not increased in the 12th Five-Year Plan period, additional new capacities will be slow to materialize, and the inefficiencies associated with an aged capital stock will continue. Sharply rising costs could exacerbate this problem. The construction materials industry will have few resources to use for mechanizing the numerous labor-intensive production processes that currently prevail. For example, according to press reports, about half of the workers in the cement sector are still employed in manual and auxiliary tasks. Planners, who hope to raise labor productivity through introduction of new high-efficiency machinery, increased mechanization and automation, and better social and cultural facilities at production enterprises, will find it increasingly difficult to modernize because all these im-

provements depend on higher rates of growth of capital investment.

The industry's efforts to improve its raw material supply position appreciably will also be affected by the performance of other industrial sectors. The plan to use more metal wastes and fly ash instead of rock products, for example, may be hampered by continued slow growth in the metals and coal industries and by transportation constraints. If fuel and power supplies cannot be made more reliable, production of construction materials will continue to falter.

In sum, unless investment in the industry is increased substantially to develop new sources of raw materials, commission new production capacity, renovate old plants, and increase output of processing equipment, continuing construction materials shortfalls will seriously hamper Gorbachev's modernization and consumer welfare efforts. Specifically, new housing starts will slow, capital renovation will be delayed, and the planned increases in the production of advanced and higher quality construction materials will not be realized.

METAL-SAVING AS A FUNDAMENTAL PRECONDITION OF INDUSTRIAL MODERNIZATION

By Boris Rumer and Yury Vatkin*

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Steel is the breed of our industry, our national resource. We must be especially frugal with it. It is necessary to be more active in applying progressive technological solutions.—Lev Zaykov, Central Committee Secretary for Industry, Politburo Member, August 1986.[1]

Summary

The modernization of the machine-building sector is one of the fundamental elements of the reindustrialization of the Soviet economy planned for the second half of the 1980s. The amount of investment in this sector of the economy is planned to increase by more than 80 percent over the level of the last five-year plan. Its output is to be raised by 40 percent. The share of output produced at the "world standard" is to reach 80–95 percent by 1990 from today's rather negligible levels.[2] In terms of its ambition, this grandiose plan can be compared only to the five-year plans of the era of Soviet industrialization. The first and second five-year plans failed because they were completely unrealistic. The current five-year plan can be compared to those plans when judged in terms of the mismatch between its ambition and prospects for success.

Introduction

Gorbachev announced in January 1987 that the problems facing the machine-building sector are being solved "with great difficulties." [3] His ecomomic advisor Abel Aganbegyan referred to the results of the first year of the plan period in the machine-building sector as "not encouraging." [4] This euphemism can be expressed in simpler terms as "very bad."

The difficulties mentioned by the General Secretary are associated with the shortcomings of the ecomomic system as a whole. They

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are discussed in other essays in this compendium. In the machine-building sector Gorbachev's program is faced with the following contradiction: the plan calls for a rapid construction of a modern building without creating a solid foundation capable of supporing this building.

One of the main components of this foundation is the question of steel supply. Ferrous metals constitute more than 95 percent of all materials used by the Soviet machine-building sector.[5] Under the conditions of shortage of steel resulting from the peculiarities of its distribution and consumption in the USSR, the fate of Gorbachev's machine-building program depends directly on the efficient use of steel. Prime-Minister Ryzhkov told the XXVII Party Congress that in the XII five-year plan period a 40–45 percent increase in the machine-building output must be accompanied by a mere 9 percent increase in the production of steel.[6] Ryzhkov stressed in his speech that growth in the machine-building sector should be achieved with the help of a more economical use of steel. Let us note that the shortage of steel has always been one of the main reasons for not fulfilling production plans cited by the Soviet machine-builders. The current five-year plan has placed an unprecedented emphasis on the effficient use of steel. Specific targets for steel economy have been included into the plan of every civilian machine-building ministry.* The statistical yearbook *Narodnoye Khozyaystvo SSSR* published for the first time in 1985 a special table dealing with "steel wastage in machine-building and metal-working."[7] Judging by the data reported in that table the share of steel wastage in total steel consumption is 22 percent and has remained constant for 25 years (since 1960). More than half of this wasted steel is a byproduct of metal-cutting.

Thus, in the XII five-year plan period the machine-building sector must plan to satisfy its demand for steel not so much by getting more metal but by using it more efficiently. For example, according to the current five-year plan, one of the main machine-building branches—heavy machine-building—must satisfy 75 percent of its new demand for steel by economizing. The use of steel in that branch of industry can be illustrated by the following statistics: in the production of locomotives 290 kilograms of every ton of steel is wastage; in the production of diesel engines 560 kilograms of every ton is wastage.[8]

Judging by published statistics, there has been an improvement in the use of steel in the machine-building sector. But even these statistics indicate that the improvement is nowhere near the plan targets.[9]

Extensive use of steel can be explained by many economic and technological factors. This paper is dealing with what we see as the fundamental obstacle standing in the way of efficient use of metal in Soviet machine-building—excessive use of casting and insufficient and technologically obsolete use of rolled metal. Here is what Premier Nikolay Ryzhkov has to say in this regard:

> In a number of branches of the machine-building industry a far higher proportion of components are produced by casting than is the case abroad, accounting for a total of 50–60 percent of the total weight of all machinery. [As a result,] from each

* We believe that this is also true for the defense machine-bulding sector.

ton of steel we produce far less finished product than is the case in the United States, Japan, and West Germany.[10]

Such patterns of steel consumption have led to proliferation of wasteful metal-cutting technologies and prevented a greated reliance on more economical press-forging processes.

This paper will address the problems of reduction of steel consumption in the machine-building sector. It will examine the state of casting and press-forging technologies in the Soviet Union. Greater use of rolled metal is a key component of the program intended to bring about efficient use of steel in the machine-building sector. It will be considered here as well.

Casting*

From the standpoint of the metal-output ratio, the extraordinarily high proportion of iron and steel casting is a characteristic feature of metal utilization in the Soviet machine-building industry. In the early-80s iron and steel casting constituted almost half of the metal used to produce machinery in the USSR or roughly 2–2.5 times more than in other industrialized countries.[11]

A survey of machine-building plants* conducted by the Central Statistical Administration in the early 1980s showed that 71 out of every 100 plants produced their own iron casting, 27—steel casting, and 84—forged pieces.[12]

Soviet specialists are well aware that the high proportion of casting hinders efforts to reduce the weight of machinery and is among the basic reasons for the high rates of consumption of metal in machine-building. But this sentence oversimplifies the situation and needs to be qualified. There are in the Soviet Union advanced techniques for the production of cast products which yield high-quality casting exhibiting a high degree of surface smoothness, with small machining allowances. However, a highly outdated mode of production of casting prevails; 80 to 90 percent of the overall output of casting is manufactured in sand molds.[13]

Because of poor tolerances achieved with castings and the need for laborious machining of the coarse, rough surfaces, in 1982 around 6 million tons of cast iron and 3 million tons of steel ended up as scrap.[14]

By smelting cast iron in induction furnaces—a technique widely used in many industrialized countries—it is possible to greatly reduce the weight and to almost double the strength of castings. But the Soviet machine-building industry uses cupolas instead. Most of them were built according to designs which are 30–50 years old. Induction furnaces have only just begun to appear at some Soviet machine-building plants. Very few plants in the early 1980's were equipped with these types of furnaces, and the volume of smelting performed was not great—roughly 3 percent to 5 percent of the total volume of output of iron casting.[15]

But the problem is not limited to the lack of induction furnaces. Modernization of casting shops cannot be accomplished by mere insertion of new furnaces in the existing environment. The whole structure needs to be completely overhauled. But this means a con-

*Most Soviet machine-building plants have their own casting shops.

siderable investment; furthermore, it would be necessary to temporarily stop or reduce the output of casting products which would constitute an extremely painful step. In general, obsolescence is a characteristic feature of Soviet casting technologies.[16]

The high degree of reliance of the casting process on manual labor hinders efforts aimed at achieving efficient use of metal in the foundry industry. Despite the feasibility of automation of the manufacture of foundry molds and cores,* manual labor still predominates. Machine-molding has the potential of reducing metal consumption in the production of castings, as well as the cost of the metal-cutting equipment. But in 1980 nearly one-fifth of all castings were produced using hand-manufactured foundry molds and cores.[17]

The shortage of foundry equipment is one of the reasons why considerable quantities of castings are manufactured by manual labor. A second reason can be found in the rather haphazard structure of the workpiece manufacturing process. It involves vast numbers of small-scale general-purpose shops where the introduction of any far-reaching changes in manufacturing technology encounters serious difficulties. In the early 1980s about 50% of all foundry shops and bays—of which there were over 5600 throughout the industry—produced less than 1,000 tons of iron castings annually (less than 3 tons a day).[18] Nearly half the shops manufacturing steel castings had annual output of less than 500 tons (less than 2 tons a day). Such volumes of output virtually preclude efficient utilization of the latest manufacturing techniques.[19]

Even in the 1960s it was already clear that further development of the Soviet machine-building industry is being held back by the poor state and inefficiency of this workpiece manufacturing base. The executives of Soviet industry saw a way of overcoming this problem in the creation of large-scale specialized enterprises that would satisfy the demand generated by different machine-building branches. The output of these enterprises would be uniform in terms of design, intended use, operational specifications for components and subassemblies. Today, within the foundry industry, there are several such large-scale specialized plants, with output of 50,000–240,000 tons annually, called foundry centers [tsentrolity].[20]

According to the original plans, the economic efficiency of these plants an the improved quality of their output should have resulted in a greater efficiency of the machine-building plants and elimination of many small scale primitive foundry shops.

But the new large-scale foundry centers have yet to play a significant role in increasing the efficiency of the foundry industry.[21] There are two basic reasons for this.

1. The foundry centers were been constructed at extraordinarily slow rates, and their construction involved costs far exceeding what had been planned initially, a factor which adversely affected the manufacturing cost of the output. Furthermore, by the time many of the plants were put into service, they had become technologically outdated.

*These processes account for 40–50 percent of the total number of man-hours involved in the production of castings.

2. The very idea of large-scale foundries was based on the assumption that a large degree of uniformity and standardization existed in the Soviet machine-building industry which would require massive production runs and result in substantial economies of scale. But in reality the degree of uniformity and standardization in the machine-building industry is very low. It requires small production runs and results in frequent readjustments in the regime of the production process.

This has resulted in a mean lot size of castings of the same type of 15 to 20 tons. By contrast, at small plants the mean lot size is 50 to 100 tons. Once the foundry centers had turned to single-unit and small-lot production, they were unable to compete with foundry shops of machine-building enterprises whose manufacturing cost were lower. Under the conditions of small-run production application of new technologies is unsuitable and economically inefficient.

Departmental segregation in the machine-building and the complications encountered in the effort to fulfill the optimal order schedule of foundry centers have led to a situation where many machine-building enterprises prefer to produce the majority (well over 80 percent of components through their own efforts. This includes even uniform an standardized components.[22] For the machine-building industry as a whole specialized foundry works produced approximately 4 percent of all castings, whereas they could produce 50 to 55 percent.[23]

Modernization of the foundry industry as a whole would entails a redesign of the foundry shops, which in many cases constitutes an awesome task. This is especially true for the machine-tool industry. Only with considerable efforts does one find at these enterprises foundry shops which are not experiencing severe difficulties. In most cases, managers of machine-building enterprises point to the foundry shops as the weakest point in their production processes. In the Soviet machine-building industry reconstruction of any enterprise must begin at the foundry shop—such is the widespread belief held by workers and managers. There can be no progress in the machine-building industry unless the foundry industry is "put into order." Clearly, this will require substantial investments. Will the additional flow of investments in the machine-building industry as a whole included in the twelfth five-year plan reach the foundry shops?

Plans for the technical development of the foundry industry through the year 2000 call for the replacement of existing capacities that now produce 2,400,000 tons of castings by means of traditional, that is to say outdated methods, by capacities designed to produce precision castings. The plans also call for an increase in the percentage of foundry cast iron smelted in electric furnaces from the current figure of 7 percent to 47 percent, together with a corresponding reduction in the percentage of cast iron produced in cupolas. According to the calculations of Soviet experts, 7 billion rubles of capital investment will be required to implement this program; in addition, it will take 10–15 years to absorb these investments.[24] Given the existing investment conditions of the current five-year plan and, we believe, of the next or thirteenth five-year plan (1991–95) as well, the allocation and absorption of this investment for the purpose of modernizing the foundry industry appears

unlikely. A more realistic approach would involve a slow-paced technological improvement fueled by a smaller flow of investment.

At the same time, candid statements in the Soviet press leave little room for doubt that drastic improvements are necessary in foundry production. Otherwise, no real program of modernization of the machine-building industry as a whole, can succeed.

Metal-Forming

Metal forging using steam and air hammers and hot stamping is still the most widespread metal-forming technology in the Soviet Union. These processes are characterized by extremely low coefficients of utilization of metal; 0.33–0.38 in the case of components made from forged workpieces, and 0.44–0.52 in the case of components made by stamping.[25]

The overwhelming majority of stamping and forging is performed in shops and individual bays of integrated machine-building enterprises with full production cycles (i.e., enterprises where the production cycle began in workpiece shops and ended in assembly shops). Similarly to iron and steel casting, Soviet machine-building enterprises have attempted to meet their needs for forged and stamped products by using their own facilities. In the early 1980s roughly 65% of all shops involved in forging and stamping were small and inefficient works producing less than 3,000–5,000 tons of output annually.[26]

There are also individual large metal-forming shops at some machine-building enterprises that produce from 150,000 to 300,000 tons of stamped metal annually in large and mass-produced lots.[27] These shops have been built in the past 10–15 years, and can be found in a number of automobile and farm machinery factories. These enterprises are being technologically modernized at a rather fast pace.

But such enterprises are relatively few. Most machine-building factories have small metal-forming facilities and their rate of technological modernization is slow. There are a number of other causes, besides their small size, which are responsible for the slow pace of technological modernization of metal-forming production shops. These include the short lifetimes of stamping tools, as well as the fact that production of these tools consumes a considerable number of man-hours. There are many purely technological problems still to be overcome, particularly with the latest processes such as high-speed stamping, stamping of powder material, extrusion of tool steel under superplasticity conditions, and so on. And finally, substantial difficulties have to be overcome if the branch is to be supplied with the most modern metal-forming equipment, difficulties which we will now discuss in some detail.

At first glance, increasing the capacities and undertaking technological modernization of the existing metal-forming equipment does not appear to be a difficult task. The amount of this equipment in the Soviet Union is already quite impressive and comparable to the United States. Furthermore, the Soviet metal-forming equipment is not very old.[28] The amount of metal-forming equipment already in existence in the Soviet economy makes it possible to process more than 34,000,000 tons of rolled product, around 2,000,000 tons of

ingots, and around 800,000 tons of plastics annually.[29] There are also data which show that over the past decade Soviet industry obtained over 50,000 units of metal-forming equipment annually, and since 1980, over 57,000 units.[30] Considering these two sets of data together, it is clear that on the whole the scale of development of the industrial base in metal-forming technology in the USSR is quite impressive indeed.

A more detailed study of this issue, however, demonstrates that the inventory of metal-forming equipment differs from one branch of the machine-building industry to another in terms of its technical state and potential for meeting the needs of a particular subbranch. Hence, the differences in the scale and nature of the problems confronting the metal-forming production of the machine-building industry.

It would seem that a strategy of large-lot and mass production would be the easiest way for the Soviet machine-building industry to accelerate the development and modernizing of metal-forming equipment. But general-purpose, nearly unautomated (manually controlled) metal-forming machinery is still the basic and most convenient type of equipment.[31] It is for this reason that growing manpower shortages are experienced especially in the sphere of small-scale production.

How can this situation be explained? The answer is in the shortfalls in the production of contemporary metal-forming equipment. According to reports published by the Central Statistical Administration of the USSR, the total value of all metal-forming equipment produced in 1985 was 17.5 percent higher than in 1980.[32] But, according to the Ministry of the Machine-Tool industry, which is responsible for 85 percent of the total volume of metal-forming equipment, the plan was supposed to achieve 52.8 percent growth by 1985.[33] Thus, the production plan for metal-forming equipment had not been fulfilled and by a very large number.

The output of numerically controlled metal-forming equipment has more than doubled over the past five years, a fact which attests to high rates of growth in this area. However, we should bear in mind that production (in physical units) of programmed controlled metal-forming machine tools, which began only in the mid 1970s, has never exceeded 70–80 units annually. Clearly, the impact of this equipment on the Soviet machine-building industry is still barely noticable.[34]

The Soviet machine-building industry has accumulated considerable experience in the production of custom-made presses. However, the creation of systems of presses equipped with efficient (reliable) automatic manipulators presents an extremely serious challenge to the Soviet machine-building industry.

Experience has demonstrated that the process of development, design, assemble, and assimilation into the workplace of custom-made metal-forming machinery takes 4–5 years even under extremely favorable conditions. Thus, the assimilation of a number of novel custom-made machines now at different stages of development and manufacture should not be expected before the end of the current five-year plan.

Judging from the claims of Soviet planners, the development of the capacities for production of metal-forming equipment fall far

short of meeting the demand for it. At the end of the 1970s certain leading specialists of the USSR Gosplan believed that the cause for the suboptimal structure of metal-working technologies in the Soviet machine-building industry (with metal-forming machines constituting only a small fraction of the total inventory of metal-working equipment) was to be found in the inadequate level of development of the press-forging machine-building sector.[35]

Even quite recently (late 1985) essentially the same point of view was advanced by Genrikh Stroganov, deputy director of the USSR Gosplan in his discussion of the tentative production plan for the Ministry of the Machine-Tool Industry for 1986. In declaring that the production of metal-forming equipment was below the plan figures, Stroganov criticized the management of the ministry, holding them largely responsible for the slow progress toward greater use of plastic deformation and continuing reliance on metal-cutting processes.[36]

Thus, production plans for metal-forming equipment have fallen far short of targets for a long time now. This is the key obstacle standing in the way of the proliferation of efficient metal-working technologies in the Soviet machine-building industry.

Range and Quality of Rolled Product

Striking the right balance between metal-cutting and plastic deformation in metal-working constitutes essentially the same task as determining the proper ratio between the amount of cast and rolled metal in the production of steel. Efforts aimed at determining the optimal quantity of rolled and cast products in the overall volume of structural materials used in the Soviet machine-building industry must deal with a number of conflicting issues. The problem has not been solved, and may never be solved as long as the range of rolled product remains entirely inadequate.

The State Planning Commission and machine-building ministries have tried to make a convincing case for doing away with cast product and replacing it with rolled product, more precisely, welded parts made from flat-rolled metal. This would help save metal by reducing the amount of scrap from machining and through the use of lighter welded parts. But Soviet steel plants are not able to supply the machine-building industry with rolled product of the proper dimensions and shape and, consequently, a considerable proportion of the metal is turned into chips in the course of machining, or scrap in gas-cutting operations.

Because of the limited range of products, no great reduction in the weight of machine parts can be achieved. As a result, the volume of metal waste in the manufacture of machine parts from rolled product is not simply not lower than when casting is used, but in fact is much higher. In the production of energy-converting machinery, metal waste in the case of rolled product is 31 percent higher, in the automobile industry 16 percent higher, and in tractor and farm machinery cosntruction 44 percent higher.[37]

The limited range of rolled product manufactured in general and an insufficient output of rolled product with enhanced strength properties in particular has led to the widespread practice of re-

placing unavailable shapes and dimensions of rolled product of a desired quality with larger sizes of sheet of reduced quality.

The result has been an increase in the weight of structures and machinery without any basis in the stress analyses nor the technological demands, and also to extraordinary volumes of waste in the machining process. Here is the reason for the low utilization factors for steel in the chemical machine-building industry (0.7), the automobile industry (0.68), and machine tool manufacture (0.6).[38]

A far lower proportion of the total volume of rolled products manufactured by the Soviet steel industry consists of flat-rolled metal, by comparison with the situation in other industrially developed countries (40–42 percent versus 60–65 percent).[39]

The use of thermally hardened and low-alloy steel sheet and roll-formed shapes is also a major factor in reducing the structural metal-output ratio of machinery. In the early 1980s, low-alloy steel sheet amounted to 13 percent of the total volume of flat-rolled product, thermally hardened rolled metal around 6 percent, and roll-formed shapes a little more than 1 percent. This is quite insufficient to meet the needs of the Soviet machine-building industry.

From the theoretical standpoint, it might be asserted that rolled product ought to supplant casting where there are no constraints on the range of products. But it is highly unlikely that these constraints will disappear in the foreseeable future. In absolute terms, therefore, the production of steel and iron casting will unavoidably increase. The Soviet machine-building industry now had no other way of producing structural metal and billets.

The chief goal in the diversification of product assortment in rolled steel production was to increase the share of sheet metal in the total production of finished rolled steel.

In the late 1960s, a scientific group within the State Committee for Science and Technology concluded that the proportion of rolled product in the form of sheet must be increased to at least 45 percent by 1975 and to 50–55 percent by 1980.[40] But the share of flat rolled steel was 38 percent in 1970, 40 percent in 1975, 41 percent in 1980, and 41 percent in 1985. But by 1985 the plan called for this proportion to increase to 45 percent. If that goal were achieved, then the production of finished rolled steel in 1985 (109 million tons) would produce a sheet steel output of 50 millions tons; but in fact only about 45 million tons are produced.

Each year the Soviet Union plans for steel mills to introduce about 100 new varieties of rolled product.[41] These plans, however, have not been implemented and remain a dead letter.

While there are many obstacles to plans for producing new types of rolled metal, the primary one is the fact that steel plants have no interest in burdening their capacities with the production of ranges that are not economically beneficial to the enterprise. It should be emphasized that, under these circumstances, this means inevitable conflicts with the consumer machine-building plants, for whom the limited product mix in rolled metal means a higher metal input, higher production costs, and in a number of cases, the general impossiblity of constructing the required machinery.

It is, furthermore, worth noting that Soviet standards for rolled steel assortments do not correspond to the contemporary demands of modern machine-building. These standards, in a very substantial

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degree, are inferior to analogous standards in the industrially developed countries of the West. Thus the Soviet standards include a smaller number of alleviated, thin-walled and especially complex forms of rolled metal.

Conclusion

The consumption of steel per unit of national income is twice as high in the Soviet Union as it is in Western industrialized countries. This situation is supposed to be corrected by the year 2000. At the same time the volume of steel output is projected to remain at the 1985 level.[42] This is dictated by the program approved by the XXVII Party Congress.

An acute and growing shortage of steel constitutes a characteristic feature of the current situation in the Soviet economy. *Sotsialisticheskaya Industria*—a newspaper of the Central Committee—wrote in late 1986 that without immediate "extraordinary measures the deficit of steel can become truly enormous. Many scholars consider the [current] situation with steel critical." [43]

According to the *Main Directions of the Development of the Soviet Economy by the Year 2000*, the solution to this problem is in the economical use of metal, increase in production of flat rolled steel, its qualitative improvements and greater variety.[44] However, contrary to the plans of the Soviet leadership, there has been no increase in the demand for rolled steel and even a decrease in its consumption by such key industries as machine-tooling and electrical machine-building. Moreover, even more telling is a forecast prepared by the machine-building ministries. They predict that, contrary to the *Main Directions* . . ., the share of rolled steel in the consumption by such industries as automobile and energy machine-building will not increase by the year 2000 and in some industries, such as machine-tooling and chemical machine-building, it will fail.[45] Gosplan's leading expert Ivan Pashko believes that in the first half of the 1980s the supply of flat rolled steel in the Soviet Union exceeded the demand for it from the machine-building sector because enterprises were not ready to use rolled metal instead of casting.[46] The ministries demonstrate their eagerness to save metal through the use of high-quality rolled product and transmit requests for the production of this type of steel to the steel plants. However, the machine-building enterprises are not ready to use it and avoid receiving it.

Due to the low inadequate technological adaptability of the machine-building industry to the pressing, stamping and welding of flat-rolled steel, there is great demand for steel and iron casting. By contrast, the demand for rolled sheet steel is relatively low. The Soviet machine-building industry is switching to high-quality rolled metal very slowly and, therefore, steel plants have little incentive to expand output of rolled product.[47] It is impossible to establish how the responsibility for inefficient use of metal should be divided between steel-makers and machine-builders. One should not expect to see the proliferation of metal-saving technologies in metal-working under these conditions.

The ministries can show great improvements in metal-saving in their reports by manipulating consumption rates. But these num-

bers have little credibility. Macro-level statistics on metal consumption reported in yearbooks and newspapers are no more reliable. According to the statistical report for 1986 "the consumption of metal per unit of national income* fell by 0.6 percent." [48] But there is reasonably solid evidence that national income indicators are not deflated.[49] As a result, the reported per unit of national income consumption of metal is lower than the real number. If adjusted for inflation, these statistics may yet reflect a further increase in metal consumption.

Based on the analysis presented in this paper, there are few reasons to predict that in the foreseeable future technological factors will provide a substantial contribution to a more efficient use of metal in the Soviet machine-building sector. Real progress in this sphere can be achieved if economic factors are brought into play and changes are made in the existing economic mechanism. But this depends on the fate of Gorbachev's promised economic reform.

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MODERNIZATION OF THE SOVIET STEEL INDUSTRY: WHAT LIES AHEAD?

By Cheryl A. Harris*

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I. SUMMARY

Modernizing the Soviet steel industry is crucial to the success of Gorbachev's industrial modernization effort. Without major improvements in the quality and variety of steel products, the General Secretary's program to develop and produce modern technologically sophisticated machinery and equipment will be seriously hampered. Accordingly, Moscow has adopted a wideranging program for reequipping the Soviet steel industry and expanding the mix of output, specifically by:

—Reconstructing older steel plants.

—Replacing open-hearth steelmaking furnances with basic oxygen or electric furnances.

—More than doubling the share of steel continuously cast by 1990.

The steel modernization program focuses on elements that could lead to improvement in product quality and variety. Gorbachev has a strong incentive to push for progress in this important industry, but the cost of effectively carrying out the program during 1986–90 may outstrip the resources available for it. Domestic machine builders will be unable to meet the demand for more reliable and sophisticated metallurgical machinery. In addition, a program based on reconstruction and technical reequipment poses particular difficulties for the Soviet steel industry.

Turning abroad for help, Moscow will find little near-term relief. Acquisition of modern Western equipment—especially turnkey projects which can be put into operation more quickly than domes-

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tically supplied facilities—will be limited by reduced hard currency earnings, probably for the rest of this decade. Nor can the Soviets depend heavily on their East European client states for much additional machinery. These countries already supply Moscow with a large share of their machinery production and are ill prepared, and probably unwilling, to meet heavy new demands for more and better machinery exports.

On balance, some progress will be made in modernizing the steel industry. For example, greater use of modern furnaces and continuous casting will improve the efficiency of the steelmaking process during the late 1980s and help the Soviets meet their goals of increasing rolled steel output without increasing production of some inputs. Completion of some of the new and renovation projects planned during 1986–90 could help meet demands for higher quality products in key sectors of the economy.

Despite these improvements, however, the Soviet steel industry will face too many obstacles to fully meet the demands of the economy, at least for the remainder of the decade. As a result, we can expect to see:

—Continuing complaints from various ministries (especially the machine-building ministries) about inadequate variety and quality of steel products which, in turn, will inhibit progress in modernizing the machine-building sector—the centerpiece of Gorbachev's industrial modernization program.

—Machines that continue to outweigh their Western counterparts, perform fewer functions, and need to be repaired or replaced more often—thus siphoning scarce resources away from modernization and into capital repairs.

—Continued need for imports of many Western steel products, such as plate and sheet for the machine-building branches and pipe for the oil and gas industries, adding to the strain on dwindling hard currency resources.

The failure to make major improvements in the steel industry over the next few years will increase the risk that Gorbachev's ambitious modernization goals for the remainder of the decade will not be met. As the Soviet leader is able to assess how modernization is faring, he may be in a position to better plan improvements that could be implemented in the 1990s. However, prolonged delays and setbacks to current modernization plans will also increase pressure on the regime to either back off its ambitious program or make more fundamental changes in the system that might provide both the incentives and the resource slack necessary for meaningful improvements to occur.

II. The Importance of Steel to Gorbachev's Modernization Program

After all, even today the lag of the metallurgical industry is affecting other sectors. If we do not ensure a drastic improvement in the quality of metallurgical industry output, if the range of goods it produces does not meet present-day and future requirements, then we will be unable to achieve the necessary breakthrough in machine building and also . . . other spheres of the national economy.—Pravda editorial, 13 November 1986.

General Secretary Gorbachev's industrial modernization program requires the ferrous metals industry to sharply improve the quality and expand the variety of steel products provided to key sectors of the economy, particularly the machine-building and energy industries. Specifically, Gorbachev's program has raised the demand for hundreds of new and better steel products—from drill pipe for the oil and gas industries, to high-performance electrical sheet for transformers, to special alloy steels for lighter, stronger, precision machine tools.

The machine-building industry is the largest consumer of steel, and meeting its demand for steel products will be crucial to achieving Gorbachev's modernization goals. The increased rate of growth planned for machine-building output in 1986–90, coupled with Moscow's call for improving the quality of domestic equipment and conserving metal, requires steelmakers to both raise the quantity of finished output and produce a larger share of new high-quality steel products and products with special properties.

Sharply growing demand for more and better quality steel products in the oil and gas industries will add to the burden on the ferrous metals industry in the coming years. The oil ministry is planning to substantially accelerate the pace of development drilling and the number of oil well completions during the 12th Five-Year Plan (1986–90). The demand for drilling rigs, drill pipe, casing, and tubing will grow accordingly. In addition, plans to develop the deep sour oil and gas condensate fields of the Pre-Caspian Depression will impose stringent requirements on the steels used in the fabrication of production and processing equipment that can withstand extremely high pressures and temperatures as well as resist the corrosive environment found in these deposits.

Finally, the defense sector will continue to demand more and better steel products as weapon systems now in the field are replaced with new ones whose performance characteristics require closer tolerances, lighter weight, and greater strength. Some weapon systems, especially armored vehicles, have traditionally consumed enormous quantities of steel. Output of weapon systems requiring specialty steels—such as advance fighter aircraft and new types of munitions which contain specialty steel materials—will require the Soviet steel industry to produce larger quantities of advance, higher quality steels.

III. A Troubled Industry

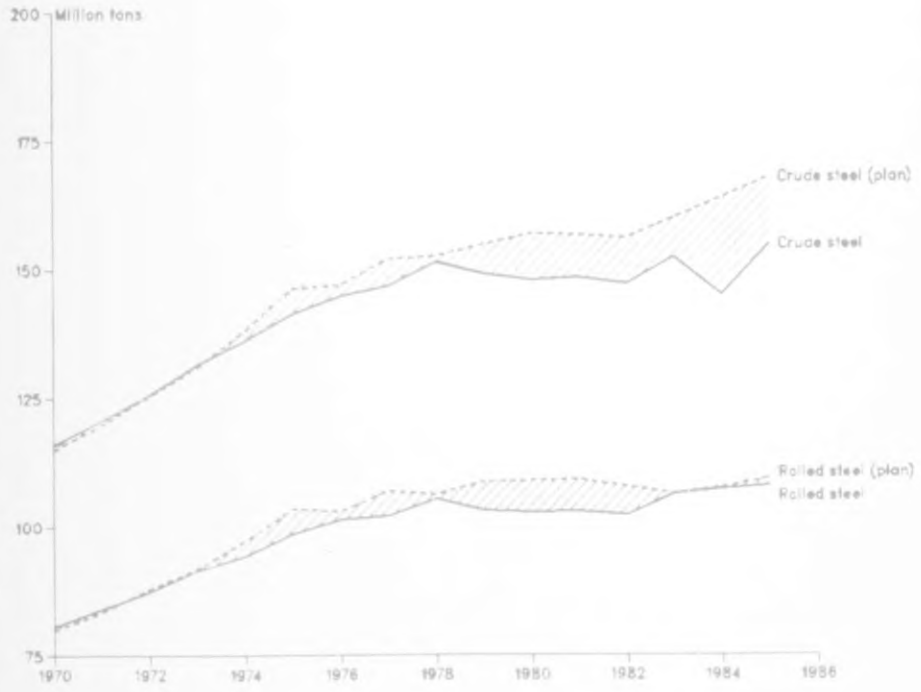
The steel industry is ill-prepared to meet the challenge of Gorbachev's call for more and better products, because of both outmoded production facilities and perverse incentives which define success (and bonus allocations) more on the basis of tonnage than on type or quality of finished product. Indeed, the overall record of the steel industry during the past 10 years has been one of traditional failure to meet expectations, despite substantial imports of Western equipment and technology (see figure 1). Previous regimes have called for steel mills to introduce hundreds of new varieties of high-quality rolled products, but the preponderance of poor quality, out-of-date domestic metallurgical machinery has fostered low quality, narrow assortment, and shortages of steel products. As one

leader in Soviet machine building characterized the situation in 1983:

> The Ministry of Ferrous Metallurgy each year provides no more than 15 to 17 percent of the new forms of rolled steel required by our industrial branch, and the actual delivery record is still worse. During 1976-80, the enterprises of the Ministry of Heavy Transport Machine Building received only 43 of the 176 forms of rolled product that they required.

Figure 1

USSR: Planned Versus Actual Production of Ferrous Metals, 1970-85



The limited availability and variety of quality steels, in turn, result in poor reliability and low efficiency of domestically produced machinery and equipment. For instance, transformers built with poor quality sheet have high energy losses. Metal input and production costs for machinery and equipment are also higher as a result of the poor quality and narrow assortment of steel products. The Soviet press reports that replacement of unavailable shapes and sizes of rolled steel products with larger sizes is a widespread practice at machine-building enterprises. Additional waste occurs when equipment designers, with a distrust of steel quality, apply a "correction factor" to their designs. Largely because of these practices, machines in the USSR outweigh their Western counterparts by as much as 25 percent.

Gorbachev seized the opportunity during a conference on science and technology in June 1985 to soundly criticize the steel industry's past performance, putting the blame on inefficient allocation of capital investment. Half of the 50 billion rubles of investment spent by the industry during the past 15 years was channeled into new construction, largely to expand basic sectors such as iron ore mining and pig iron production at the expense of reconstructing downstream production facilities to improve the quality and assortment of finished steel products.[1] As a result, the USSR has had to rely increasingly on imports to meet its domestic requirements for finished steel.[2]

Gorbachev followed up his criticism of the industry by sacking the Minister of Ferrous Metallurgy, Ivan Kazanets, in July 1985. His replacement, Serafim Kolpakov, who was first deputy of the ministry from 1981 to 1985, has promised that modernization by "technical reequipment" would be the wave of the future.

IV. The Current Steel Modernization Program

We have recently taken some far-reaching measures with respect to the cardinal issues of economic growth. I mean the resolutions calling for a fundamental reorganization of metal production. . . . —Mikhail S. Gorbachev at a June 1986 CPSU Central Committee meeting.

With modernization of the steel industry virtually as important as modernizing machine building itself, Moscow has adopted a wide-ranging program for reequipping the industry. In comparison with past efforts that focused on increasing production capacities, the current plan emphasizes plant renovation and replacement of outmoded equipment, specifically by:

—Reconstructing older steel plants.

—Replacing open-hearth steelmaking furnaces with basic oxygen or electric furnaces.

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[1] The term "reconstruction" is used loosely by the Soviets and includes replacement of equipment and facilities, renovation of existing equipment, and creation of completely new facilities to correct disproportions in capacities of various stages of the steelmaking process at a plant. According to the Soviet press, in recent five-year plans only 1 percent of investment went toward replacing iron-melting, steel-smelting, and rolling capacity. The few metallurgical machines taken out of service since 1975 were 2 to 2.5 times older than their design life. Soviet literature reports that, meanwhile, repair expenditures for maintaining existing equipment in working condition are increasing each year. In 1983, repair expenditures exceeded allotted capital investment in the industry by about 35 percent.

[2] The value of hard currency imports of finished steel products increased from about $600 million during 1966–70 to about $17 billion in 1981–85.

—More than doubling the share of steel continuously cast by 1990.

According to the Soviet press, 50 percent of investment in ferrous metals during 1986–90 will be used to renew existing plants, 30 percent will go toward improving product variety and quality, and only 20 percent will finance capacity expansion. This is in sharp constrast with past five-year plans, which allocated up to 75 percent of investment to capacity expansion (see table 1).

TABLE 1.—USSR: CAPACITY ADDITIONS IN FERROUS METALLURGY, 1976–85

(In million tons)

	1976–80 annual average	1981	1982	1983	1984	1985
Pig iron						
Total capacity	1.1	0.4	0.3	0	0	0
Reconstruction	0.2	0.4	0.3	0	0	0
New enterprises and expansion	0.9	0	0	0	0	0
Crude steel						
Total capacity	2.9	1.3	2.4	0.3	2.2	0.9
Reconstruction	1.1	0.1	2.4	0	0.1	0
New enterprises and expansion	1.8	1.2	0	0.3	2.1	0.9
Rolled steel products						
Total capacity	1.5	2.2	0.8	1.6	1.5	1.3
Reconstruction	0.1	0.6	0.2	0.2	0.4	0.4
New enterprises and expansion	1.4	1.6	0.6	1.4	1.1	0.9

Source: Narodnoye khozyaystvo SSSR, various years.

The 1986–90 Plan provides further details on the new program's implementation. Overall gains in output are to be achieved not with increases in production of either inputs such as coke and pig iron or in the size of the labor force, but with increases in labor productivity and resource savings.

Savings of Rolled Steel Products

The 12th Five-Year Plan calls for total savings of 12–14 million tons of rolled steel, mostly in machine building and construction. If this target is to be achieved, total consumption in 1990 would be 12–14 million tons less than that which would have been obtained if 1985 efficiency standards had prevailed. Resource conservation has been espoused before, and the Soviets have achieved some recent success. A leading Soviet journal reported, for example, that the use of new types of steel for the walls and roofs of railroad freight cars during the last 10 years has reduced metal consumption by as much as 200 kilograms per car. Additionally, design changes have reduced the weight of the load-bearing structures of freight cars by 20 to 25 percent. According to the official Soviet statistical handbook, the USSR achieved about 90 percent of the rolled ferrous metals savings—8.6 million tons—designated for the 11th Five-Year Plan (1981–85).

Four recurrent themes appear in the Soviet press as ways to achieve the 1990 goal of reducing rolled steel consumption in machine-building:

—Reorganize the structure of rolled metal output and increase the relative share of "progressive forms" of steel products, including cold-rolled sheets, heat-treated steel, low-alloy steel, sheets with protective coatings, and high-precision shapes.

—Modernize the technology for the manufacture of steel products.

—Design equipment and facilities that make more efficient use of materials.

—Develop the use of substitutes for steel such as ceramics, plastics, chemical fibers, aluminum, and composite materials.

Greater use of numerically controlled machine tools and minicomputer-controlled metal-cutting machinery would reduce waste from cutting steel sheet. According to the Soviet press, the use of heat-treated steel in machine building reduces steel consumption by 25 percent, and only 15 to 20 percent of demand for this steel is being satisfied. Although substitution possibilities in machine building are limited, the Soviets want to make additional use of aluminum and plastics to decrease weight and increase resistance to corrosion. According to another journal article, under Soviet conditions one ton of plastic structural materials can replace as much as 4 to 5 tons of rolled sheet in machine building.

Soviet press comments indicate that substitution will be the main method for saving metals in construction during the 12th Five-Year Plan. Greater use of ceramics, composites, and certain types of concrete not only can reduce consumption of steel, but can result in lighter, stronger structures. The potential for saving metal through other methods also is high. For example, a survey recently done by the USSR State Committee for Construction and the Ministry of Ferrous Metallurgy examined 432 designs for pipe systems in 11 branches and found that many planned to use thick-walled pipe when it was not necessary. The Soviets estimate that more efficient use of steel pipe would result in an annual savings of about 370,000 tons.

The USSR, however, probably will not be able to tap enough of this existing potential to reach the 12th Five-Year Plan savings target. A key to the success of the program is for the ferrous metals industry to provide the proper mix of steel products, but an Izvestiya article in June 1986 reported that metallurgical enterprises had not fulfilled annual plan targets for the production of almost one-third of the economical types of metal. Additionally, enterprises are unlikely to experiment with new designs given the tremendous push for increased machinery production. For example, several machine-building ministries were criticized for backlogs in producing newly-designed equipment that uses less metal. A question also exists as to whether steel-consuming industires can handle certain high-quality steel shapes. For example, a change in the composition of metalworking equipment will be needed to make use of increased production of flat steel.

The emphasis on resource savings is illustrated in Moscow's call for average annual increases of 4½ percent in industrial production and 7½ percent in machine-building and metalworking output with less than a 2-percent average annual increase in rolled steel products during the plan period.[3]

According to statements by senior Soviet officials, priority in reconstructing steel plants during 1986–90 will be given to facilities constructed before World War II such as those at Magnitogorsk (see table 2):

—The Soviets plan to replace 30 million tons of open-hearth capacity with basic oxygen or electric furnaces over the next five years.[4] According to a Western metals journal, former Minister Kazanets stated that the widespread use of open-hearth furnaces—which are more costly to operate and more restrictive in output—constitutes the biggest bottleneck to improvement of the steel industry's overall performance. New facilities to house the new furnaces will have to be built at most, if not all, of these plants because existing structures are too small.

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[3] CIA analysts estimate that during 1981–85, the output of rolled steel products rose by 1 percent per year while industrial production and machine-building and metalworking output increased only 2 and 1½ percent, respectively.

[4] There are three basic types of steelmaking furnaces: open-hearth, basic oxygen, and electric. The Soviets still rely on the outmoded open-hearth furnace for more than one-half of their steel production, in sharp contrast with Western countries. In 1985, the United States produced only 7 percent of its steel in open-hearth furnaces, and none are now being used in West Germany and Japan. Although only a very small share of investment in steel production during 1971–85 went into building new open-hearth furnaces in the USSR, existing furnaces were maintained through repair and modernization.

—All new steelmaking shops, including those at plants undergoing modernization, are to be equipped with continuous casting equipment.[5]

—A Soviet journal reports that rolling mills and pipe-producing shops will be upgraded by removing outdated equipment, reconstructing some existing units, and creating new facilities. Chairman of the Council of Ministers Nikolay Ryzhkov has indicated that 70 rolling mills will be reconstructed and 38 will be decommissioned. Improvement of rolling mills is a key to providing the 500 types of new steel products called for in the five-year plan.[6]

TABLE 2.—USSR: SELECTED STEEL MODERNIZATION OBJECTIVES

Complex	Re-equip or build coke plants	Increase capacity of blast furnaces	Replace open-hearth furnaces	Increase continuous casting capacity	Re-equip or build rolling mills	Build new finishing lines
Magnitogorsk [1]		XX	XX	XX	XX	
Dneprodzerzhinsk			XX	XX		
Kuznetsk [1]			XX	XX		
Novolipetsk		XX			XX	XX
Petrovsk			XX	XX	XX	
Liepaja [1]			XX	XX		
Orsk-Khalilovo	XX	XX	XX	XX		
Karaganda				XX	XX	XX
Zhdanov (Ilyich)					XX	
Serp i Molot					XX	
Rustavi					XX	

[1] Indicates that reconstruction projects are specifically mentioned in the 1986–90 Plan directives approved by the Supreme Soviet in June 1986.

Despite the emphasis on reconstruction, some new capacity is to be added in 1986–90, often with the assistance of Western firms. The plan calls for capacity additions at plants in Orel, Zhlobin, Volzhskiy, and Oskol. Additional output is planned to come from an electrical-grade steel shop at Novolipetsk, scheduled to start production in 1986 and from a new minimill at Komsomol'sk na Amure, which was commissioned in late 1985.[7] The 1986–90 Plan

[5] In the traditional steelmaking process, molten steel is poured from furnaces into large rectangular molds to form ingots. After cooling, the ingots are mechanically pulled away from the molds and placed into reheat furnaces to raise the temperature of the metal so the ingots can be rolled into primary shapes—slabs, blooms, and billets. In the continuous casting process—which the Soviets pioneered—molten steel is poured directly into molds from which primary shapes are directly cast and then rolled. This process saves energy and labor and produces steel that is more homogeneous. The amount of steel continuously cast in the USSR has been growing at an average annual rate of 7 percent since 1970 to more than 18 million tons in 1983 (about 12 percent of total crude steel production), the last year for which data are available. This progress is modest when compared with the West where about one-third of US steel and over two-thirds of Japanese and West German steel is continuously cast. Because the maximum benefits of continuous casting are realized only when it is used with basic oxygen or electric furnaces, the slow replacement of open-hearth furnaces has limited the increased use of this technology. The lag in introducing more continuous casting equipment has also hampered Soviet efforts to improve yield—the ratio of rolled steel production to crude steel production—in steelmaking operations.

[6] Old and obsolete rolling mills in the USSR have been the main obstacle to expanding the variety of rolled products. Although costs at these mills are high and labor productivity low, retirement has been slow.

[7] A minimill is a relatively small steel plant that contains electric furnaces and continuous casting and rolling equipment. Because the raw material for steelmaking in a minimill is normally scrap, these facilities do not have the coke ovens or blast furnaces used to make pig iron at a fully integrated steel plant. The annual production of a minimill is usually between 50,000 and 500,000 tons of a limited variety of rolled steel products.

also includes plans to commission new manganese and iron ore mining capacity to help offset production declines caused by falling ore grades and mine depletion in older basins.

V. Roadblocks to Modernization

A. Investment Constraint

The current steel modernization program seems to be focused on the right elements to improve Soviet steel production, but the cost of the program may outstrip the investment resources available for it.

- —Emphasis on renovation and replacement of steelmaking furnaces and rolling mills could improve product quality and variety, but will require large outlays for new equipment and, in many cases, expenditures for construction of new plant facilities to house the equipment. Additionally, Soviet literature reports that reequipment has been limited in the past because the cost of new equipment has grown more rapidly than increases in the technical level and reliability.[8]
- —Western-supplied *turnkey* projects could be put into operation more quickly than both domestically supplied or Western-supplied *nonturnkey* facilities, but hard currency constraints likely will limit the number of such projects.
- —Stressing resource savings and increased use of steel scrap could limit the use of scarce raw materials, such as iron ore and coking coal, but substantial savings must await acquisition and installation of costly new, more efficient metallurgical equipment. Moreover, as in the past, investment may have to be diverted from improvement of rolling and finishing processes to the iron ore sector. During 1976–80 almost 30 percent of investment in the ferrous metals industry had to be allocated to iron ore production and beneficiation to offset the declining quality of ore.

Thus, while the Soviets seem to be attacking key problems that have long plagued the steel industry, success is dependent largely on how much investment can be made available quickly for renovating old plants and building new ones as well as for acquiring modern metallurgical equipment. Investment in ferrous metallury was slighted during 1981–85; it will have to increase sharply in 1986–90 to provide for the sector's modernization. Although Moscow planned to increase investment in ferrous metals by 30 percent in 1986, it is doubtful that such an increase can be sustained during 1987–90. Increases in total investment throughout the economy are slated to average only 5 percent annually during 1986–90, and competition among the various sectors is keen. In a recent speech to the Supreme Soviet, Ryzhkov stated that 80 percent of the total increase in investment in 1986–90 will be allocated to support the Food and Energy Programs, the development of civilian machine building (presumably including metallurgical machine building), and expansion in output of electronic and chemical products.

[8] Prices for metallurgical equipment increased 130–220 percent in 1982 without substantial increases in the quality of the equipment.

B. MACHINERY CONSTRAINT

Moscow also will face tough problems trying to improve the quality of domestic machinery which is often unreliable and technologically out of date.[9] According to *Pravda*, only about 2 billion rubles were spent on development of metallurgical machine building in the last five-year plan, while five times that amount was spent on the repair of metallurgical equipment during the same period. The reliability of metallurgical equipment is especially important because incapacitated units can often disrupt the whole steelmaking production process because of its continuous nature. Improvements in metallurgical equipment production will be further inhibited because such equipment is not produced at specialized plants but as a sideline at heavy-machine-building enterprises. *Pravda* reports that at several of these plants the proportion of metallurgical equipment in the total volume of output is declining.

Workers and management at machine-building plants generally lack appropriate incentives for producing metallurgical equipment, especially the complex and labor-intensive machinery needed for rolling mills and finishing operations. But Gorbachev's emphasis on an immediate acceleration in economic growth leaves little or no slack in any facet of the machine-building industry. Indeed, the increased pressure on plant managers to boost current production will inhibit innovation that carries any risk of failure and will reinforce the tendency to reproduce the same pattern of output that has prevailed for years, only faster and—unless major gains are made in quality control—perhaps in a more slipshod manner.

C. SPECIAL PROBLEMS OF RENOVATION

In addition to the difficulties of supplying new and better machinery, a program based on reconstruction and technical reequipment poses particular difficulties for the steel industry. Managers of machine-building plants prefer to manufacture serial, standardized equipment, but under the current modernization program, much of the new equipment must be custom made to fit into existing buildings at plants under renovation. Moreover, the renovation strategy has traditionally been resisted by managers of steelmaking enterprises because the downtime required to replace old machinery, as well as the uncertainty inherent in new production processes, threatens their ability to achieve short-term performance goals. Renovation of rolling mills, for instance, usually requires that the facility be shut down.[10]

Of equal concern to enterprise managers may be how quickly workers adapt to the use of the new equipment, which often is more complex and requires more training to operate and maintain. According to a Soviet radio broadcast, the Ministry of Ferrous Met-

[9] For example, economist Abel Aganbegyan was recently critical of a new electric furnace shop constructed at the Kuznetsk Metallurgical Plant that does not use the latest technology.

[10] In some instances, shutdown is not required. Because most new basic oxygen and electric furnaces probably will be housed in new facilities, the Soviets will be able to continue basic steel production from existing open-hearth furnaces until they are ready for replacement. After two basic oxygen furnaces are built at Magnitogorsk, for example, the Soviets report that an open-hearth shop at the plant will be phased out. Although this will help keep quantity up during renovation, it will do little or nothing toward improving quality in the usual drawn-out construction period.

allurgy intends to strenghthen the training of the labor force by means of handing over experience from one worker to another and by sending people to special training courses. But intentions may not be enough.

Appropriate incentives must also be given to construction firms which, according to a *Pravda* article, have generally steered clear of renovation projects because they tend to be more labor intensive than when construction is started from scratch. Many construction trusts are already suffering from labor shortages. A Soviet broadcast in mid-1985 reported that the Zhdanov Metallurgical Construction Trust, the main contractor for renovation work at the Azovstal' plant, was behind schedule in rebuilding a rolling mill because of a manpower shortage. Earlier last year, the Soviets reported a shortage of workers for assembling new rolling equipment at the Karaganda steel plant.

D. LIMITED HELP FROM ABROAD

Given the difficulties the Soviets are likely to encounter with the domestic supply of modern metallurgical machinery, Moscow almost certainly will turn to its CEMA allies, particularly East Germany and Czechoslovakia, to supply additional equipment. The Soviets have been importing East European metallurgical equipment for years, particularly for rolling mills, which often is of better quality than domestically produced equipment (see table 3). East Germany's Sket has supplied about 30 rolling mills that manufacture 17 percent of Moscow's rolled steel products and is slated to renovate nine light-section rolling mills in the USSR during 1986–87. Sket currently is supplying the rolling equipment for the minimills at Rybnitsa and Komsomol'sk na Amure. The Western press reports that the design for this equipment is similar to the rolling mill built by an Austrian firm at the Zhlobin minimill.

TABLE 3.—USSR: IMPORTS OF METALLURGICAL ROLLING EQUIPMENT, 1975–85

(In millions of dollars)

	1975	1980	1981	1982	1983	1984	1985
Total	211	486	429	579	443	404	446
Developed countries	90	184	157	244	199	109	184
CEMA countries	120	284	252	315	200	263	227
Czechoslovakia	72	193	165	193	127	109	127
East Germany	42	72	67	104	55	129	74
Hungary	6	19	20	18	18	19	26
Poland						6	
Other	1	18	20	20	44	32	35

Source: Vneshniaia torgovlia SSSR, various years.

It is questionable how much additional high-quality equipment Eastern Europe can provide. Moscow already absorbs a large share of East European machinery production, and most of these countries lack the capacity to expand exports to the USSR much further without cutting into their exports to the West. Thus, it is unlikely that Moscow will be able to depend on its CEMA allies to compensate fully for the shortcomings of Soviet domestic machine building.

Undoubtedly the Soviets will turn to the West to purchase equipment for some of the projects underway or planned, but they simply cannot afford to import all the needed equipment. The blow dealt to Moscow's main source of hard currency revenue by the collapse of world oil prices will limit Soviet foreign exchange spending to items of the highest priority, probably for the rest of the decade. The volume of future imports of Western equipment is likely to depend largely on the terms Moscow is able to negotiate with Western firms. Moscow has an excellent credit rating and may push for additional loans with lower interest rates and longer repayment terms for pending projects.

Moscow recently decided to allow greater Western participation in future joint venture projects including foreign equity, increased management and quality control, repatriation of profits, and other prerequisites to make such ventures attractive to Western firms. Such arrangements could have several advantages for the Soviets:

—A management role for the Western firm would facilitate the transfer of technical know-how related to organization and management of production and the use of advanced technology, knowledge not easily transferred through traditional equipment purchases.

—A long-term equity relationship with a Western firm could allow for automatic updating of production lines to keep up with changing Western steelmaking technology. At a minimum, a vested interest by the Western firm—backed by sustained on-site presence—could improve the use of Western equipment and technology.

—Quality control by the Western partner could help assure that steel products come close to, if not meet, world standards.

—Such arrangements would allow for the transfer of Western technology at little or no hard currency cost to the Soviets until after production begins.

Despite these potential advantages to Moscow, Western steel firms are unlikely to rush to enter into such joint ventures. Years of dealing wth the cumbersome Soviet bureaucracy, poor-quality Soviet raw materials and semi-finished goods, and negotiations that go on interminably will make most Western businessmen wary. Moreover, the Soviets themselves are apt to approach such negotiations cautiously. Granting the amount of control over production processes that would probably be required by the Western firms would go against the grain of most Soviet managers. At present, it appears that there is still a considerable amount of uncertainty among mid-level Soviet officials over what exactly such joint ventures would entail.

VI. Outlook and Implications

On balance, the Soviets will likely fall far short of meeting the modernization goals for the steel industry, although some progress will be made. A greater share of steel will be produced in modern furnaces—basic oxygen and electric—and more of this steel will be continuously cast. These steps will improve the efficiency of the steelmaking process and help the Soviets meet their goals of in-

creasing rolled steel output without increasing production of some inputs, which is essential if investment is going to be concentrated on upgrading metallurgical equipment. Moreover, less dependence on outmoded open-hearth furnaces will give the Soviets more flexibility to produce additional quantities of specialized alloy steels, which cannot be produced in these furnaces.

Completion of some of the new and renovation projects planned during 1986–90 may help meet demands of key sectors of the economy. For example, when the plant at Volzhskiy reaches full capacity, it will provide almost 10 percent more seamless pipe to the economy than was produced in 1985. Moreover, pipe from this plant should prove more reliable in the oil and gas industries and could lead to fewer delays in drilling and developing new oil wells.

Despite some improvements, the Soviet steel industry will face too many obstacles to fully meet the demands of the economy during 1986–90. In addition to problems with domestic machinery supply and factors within the system that are likely to inhibit renovation, Moscow will not be able to count on much help from its CEMA allies or on a sharp upsurge in purchases of Western equipment and technology. If the stock of metallurgical plant and equipment is not modernized on a large scale, the industry's ability to conserve raw materials will be limited and investment will have to be channelled into expanding iron ore production and beneficiation. As a result, the amount of new and better steel products flowing from the industry will fall well below that demanded, and we can expect to see:

- —Continuing complaints from various ministries (especially the machine-building ministries) about inadequate variety and quality of steel products which, in turn, will inhibit progress in modernizing the machine-building sector—the centerpiece of Gorbachev's industrial modernization program.
- —Machines that continue to outweigh their Western counterparts, perform fewer functions, and need to be repaired or replaced more often—thus siphoning scarce resources away from modernization and into capital repairs.
- —Continued need for imports of many Western steel products, such as plate and sheet for the machine-building branches and pipe for the oil and gas industries, adding to the strain on dwindling hard currency resources.

Moscow's continued dependence on Western imports for quality steel products will be particularly vexing to the leadership in view of its hard currency limitations. In the past, Moscow has been able to afford both steel products and steelmaking equipment. Soviet planners will have to weigh carefully the tradeoffs between purchasing Western plant and equipment to upgrade the technological level of the steel industry and importing Western steel products to meet the immediate needs of key machine-building and energy-producing sectors.

Cutbacks in Western equipment purchases in favor of steel products would slow further the pace of steel modernization and widen the gap between Soviet and Western steelmaking technology. Even if the Soviets opt to continue purchases of Western steelmaking equipment, progress in modernizing the USSR's steel industry is

not likely to proceed fast enough to keep pace with developing technologies in the West. Indeed, research now underway in Western Europe, Japan, and the United States promises innovative new technologies that will fundamentally change the way steel is made in the 1990s.

SELECTED ADVANCED STEELMAKING TECHNOLOGIES

Technology	Description	Major Advantages	Status in West
Direct-current arc furnace	Process in which a direct current passes down an electrode through an arc into the metal charge	33-to 50-percent reduction in electrode consumption less frequent need for refractory maintenance small degree of energy conservation	Limited-scale commercial application
Continuous-charging electric furnace	Process in which raw materials are added on a continuous rather than a batch basis	150-percent increase in labor productivity 30-percent reduction in electricity consumption 40-percent reduction in electrode consumption 50-percent reduction in manpower costs	Do
Combined-blowing oxygen furnaces	Steelmaking processes that combine the advantages of top-blowing and bottom-blowing oxygen furnaces	flexibility for greater scrap usage	Development and limited-scale commercial application
Ladle metallurgy (argon-oxygen decarburization, vacuum degassing and refining, and electron-beam remelting)	Processes that remove impurities from either molten metal poured directly from conventional furnaces or remelted steel	increased quality control increased labor productivity	Used extensively for alloy steel production but gaining wider use in production of carbon steel
Horizontal continuous casting	Continuous casting process that uses horizontal molding machines rather than curved	decrease in internal cracks reduction of inclusions more efficient at producing smaller products	Limited-scale commercial application
Hot charging and direct charging to the hot-rolling mill	Hot charging allows only some cooling, followed by a minimum of reheating, before charging to the rolling mill. Direct charging process sends the semifinished steel directly from the casting machine to the rolling machine without reheating	substantial energy savings increase in yield	Advanced R&D
Direct iron smelting	Process to replace blast furnaces and coking and sinter plants. Iron reduction is carried out in a separate chamber from smelting, allowing gasification of ordinary coal both to create reduction agent and heat needed for smelting	reduction in operating costs reduction in capital costs use of ordinary coal instead of metallurgical coal	Pilot plant (contract awarded in 1985 to build first commercial plant)
Near-net-shape casting	Process to extend today's continous casting of semi-finished steel to cast either a thin slab 1 to 2 inches thick or to directly cast steel strip 0.1 inch in thickness	substantial energy savings reduction in labor costs reduction in capital costs improvement in quality	Testing (commercial application of thin slabs, 3 to 5 years; thin strip 10 to 15 years)

Thus, the Soviets will need to acquire these technologies either through their own research and development (R&D) or from the West. Moscow will want to pursue these new technologies because they offer felxibility to use more abundant resources or save on energy use.[11] Direct iron smelting would be especially beneficial for the Soviet steel industry because it eliminates the need for coke. Shortages of coking coal have constrained Soviet steel production for some time, and this problem will probably grow worse in the future. Technologies such as near-net-shape casting, continuous-charging electric furnaces, and hot or direct charging for rolling mills promise substantial energy savings. Moreover, many of these new technologies cost less per ton of capacity than conventional processes. Soviet steel authorities are likely to be attracted to any technology that not only cuts operating costs but also stretches limited investment funds.

In the meantime, the Soviet steel industry will continue to come up short in terms of both the regime's expectations and the needs of the machine-building sector. The failure to make major improvements in the steel industry over the next few years will make industrial modernization more difficult and protracted, increasing the risk that Gorbachev's ambitious modernization goals for the remainder of the decade will not be met. As the Soviet leader is able to assess how modernization is faring, he may be in a position to better plan improvements that could be implemented in the 1990s. However, prolonged delays and setbacks to current modernization goals will also increase pressure on the regime to either back off its ambitious program or make more fundamental changes in the system that might provide both the incentives and the resource slack necessary for meaningful improvements to occur.

[11] The Soviets are already working with West Germany's Krupp Industrietechnik to develop a 100-percent scrap-based oxygen furnace to limit the use of iron ore.

THE SOVIET PETROCHEMICAL INDUSTRY

By Matthew J. Sagers* and Theodore Shabad**

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I. Summary

This study examines the development of, as well as the prospects for, the Soviet petrochemical industry, emphasizing a few major bulk organic chemicals. Although the Soviet programs for industrial modernization in the 12th Five-Year Plan largely focus upon the machine-building sector and the construction industry, the petrochemical industry is in a crucial supporting position, as it is a supplier of intermediate chemicals used to produce synthetic materials and many other end-products required by the modernization program. The advanced nature of these types of products and their growing use in the machine-building and construction industries make the performance of the petrochemical industry an important determinant for the success of the 12th Five-Year Plan goals. The petrochemical industry also is relatively energy-intensive and a major user of petroleum raw materials, so it is an important sector to examine in the context of the Soviet drive to economize on these raw materials.

The Soviet petrochemical industy is relatively new, really dating only from the 1950's, and is still small compared to that of other countries. Early development focused almost exclusively on producing synthetic ethanol for the synthetic rubber industry, and it was

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not until the 1960's that the industry began to diversify to supply a wider range of intermediates to a broader range of synthetic materials industries. Equipment began to be imported for the industry in the 1970's, and much of the recent expansion and diversification in the industry has been based on imported equipment and designs, mostly from the West. Currently, about 30 percent of ethylene, nearly 50 percent of benzene, over 90 percent of xylenes, and about 65 percent of methanol are produced on imported Western equipment.

In the 12th Five-Year Plan, the expansion of basic petrochemicals is projected to continue at a fairly rapid rate, largely driven by the demand for modern plastics and fibers. However, this expansion may be constrained by the availability of equipment and feedstocks. The possible shortage of equipment stems from long-existing weaknesses of the domestic chemical engineering industry. It also has been losing ground since the 1970's, with much of its capacity being sapped to meet high priority needs for the oil and gas industries. Imports traditionally filled the gap, but no imports of equipment seem to be on the horizon for the 12th Five-Year Plan. Feedstock shortages are already a problem for many plants, mostly due to the dramatic shifts in hydrocarbon production among the regions since the 1970's, as well as the overall tightness in petroleum supplies. The industry also has been very slow to follow world-wide trends in shifting regionally to utilize more gaseous feedstocks, now coming mostly from West Siberia.

II. Introduction

The new 12th Five-Year Plan (1986–1990) calls for a massive transformation or restructuring (*perestroika*) of the Soviet economy through an industrial modernization program to improve overall growth rates (*uskoreniye*) and the quality of output.[1] Although much of this is to be necessarily focused upon the machine-building sector (the economy's basic source of capital goods), the petrochemical industry is in a crucial position to support the Soviet programs for industrial modernization as a supplier of intermediate chemicals used to produce synthetic materials and many other end-products required by the modernization drive.

The advanced plastics and synthetic fibers are particularly important elements in modernizing the machine-building industry and construction, two sectors specifically singled out for "transformation" in the 12th Five-Year Plan. After the chemical industry itself (for manufacturing chemical fibers and paint ingredients), they are the largest consumers of plastics and resins. The larger is machine-building, accounting for 26 percent of domestic plastics consumption in 1983. Within machine-building, the largest single consuming sector is the electro-technical industry, one of the key areas in Gorbachev's modernization plans. It alone utilized nearly half of machine-building's plastics consumption, or 12 percent of the the USSR total.[2] The construction industry also used 12 per-

[1] Ed A. Hewett, "Gorbachev's Economic Strategy: A Preliminary Assessment," *Soviet Economy*, Vol. 1 no. 4 (October-December, 1985), p. 285–305; *Pravda*, June 19, 1986.

[2] V.V. Listov, Khimicheskaya promyshlennost' v odinnatsatoy pyatiletke. Moscow: Khimiya, 1984, p. 14.

cent of Soviet plastics, and its consumption has been growing very rapidly in recent years. For chemical fibers, the dominant user is light industry (accounting for 76.5 percent of consumption in 1983), basically for textiles and fabrics, but 9.8 percent of these fibers are used to produce various technical manufactures for other industries (i.e. electronics and optics), and another 19.5 percent is for tire manufacture.[3]

Also, the petrochemical industry is relatively energy-intensive and utilizes large amounts of petroleum raw materials and energy, so it is an important sector to examine in the context of the Soviet drive to economize on these raw materials and energy sources.

III. Petrochemical Production and Raw Materials

A. Nature of the Industry

Petrochemicals are simply chemicals manufactured from feedstocks obtained from oil and gas, rather than coal or agricultural products. Petrochemical *products* are used in a wide variety of applications, such as making plastics, synthetic fibers, synthetic rubber, detergents, paint ingredients, and thousands of other industrial and consumer goods. These various end-use products are derived from a small number of primary and intermediate petrochemicals, and these constitute the principal focus of this paper. Primary petrochemicals are those obtained directly from feedstocks, with few direct end-uses; they are chiefly converted into intermediates and/or finished products.

Three basic groups of hydrocarbons (compounds in which hydrogen and carbon atoms are combined) form the basis for the petrochemical industry: the paraffin or methane series, olefins/diolefins, and aromatics. The paraffins comprise the feedstocks or raw materials used in petrochemical synthesis. These include methane, ethane, propane, butane, and pentane. The feedstock materials which are comprised of these hydrocarbons include natural gas, which is mostly methane; natural gas liquids, which are ethane, propane and the butanes (the liquefied petroleum gases or LPG), pentanes, and natural gasoline (a mixture of the heavier hydrocarbons); and petroleum liquids, which are liquefied refinery gases (propane and butane), naphtha (low-octane gasoline), and gas-oil (heavier distillates in the kerosene-diesel fuel range).

The olefins/diolefins combine readily with other elements, and so form the backbone of modern petrochemical synthesis. The principal olefins are ethylene and propylene, while butadiene is the main diolefin. These primary petrochemcials are manufactured mostly from the high-temperature breakdown, or "cracking", of paraffin hydrocarbons, a process also known as pyrolysis. Ethane, propane, butane, and the heavier paraffins can be "cracked" to olefins, although methane, the chief constitutent of natural gas and the simplest member of the paraffin series, cannot. Methane also is used to produce methanol and ammonia, but in quite different processes, and butane and pentane are used to directly produce butadiene and isoprene, two important synthetic rubber monomers.

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[3] Listov, 1984, p. 18.

The members of the third hydrocarbon group, the aromatics, are also quite reactive, and therefore also are used extensively in petrochemical synthesis. The simplest, but most important, aromatic is benzene; the other major aromatics are toluene and the three isomers of xylene. The principal process used in manufacturing aromatic hydrocarbons is catalytic reforming, also of low-octane gasoline fractions, although a signficiant amount of Soviet benzene also is produced from pyrolysis as a byproduct of olefin manufacture.

B. PETROCHEMICAL FEEDSTOCKS

Although petrochemical feedstocks (the raw materials used by the petrochemical industry) are not a major claimant upon Soviet petroleum resources, petrochemcial needs are significant since the industry requires the light fractions, especially low-octane gasoline (naphtha), that are in relatively short supply.[4] Currently, the USSR relies heavily upon petroleum liquids for petrochemical feedstocks. For example, about three-quarters of pyrolysis feedstocks (i.e., olefin raw materials) are refinery liquids, of which two-thirds are low-octane gasoline (Table 1).

TABLE 1.—PYROLYSIS RAW MATERIALS

(In percent of the total)

Raw material	1960	1965	1970	1975	1977	1979	1980	1985 [1]
Refinery gases and ethane	34.0	17.0	3.0	10.0	n.d.	6.8	n.d.	n.d.
Ethane	n.d.	n.d.	7.5	4.0	6.5	5.1	5.8	6.8
Dry (refinery) gases	n.d.	n.d.	(2)	4.3	n.d.	1.7	n.d.	n.d.
LPG and dry (refinery) gases	n.d.	n.d.	n.d.	n.d.	24.4	n.d.	20.7	11.1
LPG (Kaviev)	n.d.	n.d.	55.6	32.7	n.d.	20.9	n.d.	n.d.
LPG (Rabkina)	45.0	61.0	40.5	27.0	n.d.	n.d.	n.d.	n.d.
Gasoline and gas-oil	21.0	22.0	56.5	63.0	69.1	72.3	73.5	82.1
Gasoline (naphtha)	(2)	13.0	20.5	40.8	62.0	60.1	67.2	82.1
Gas-oil (kerosene, diesel fuel)	21.0	9.0	16.4	18.2	7.1	12.2	6.3	(2)

[1] Forecast.
[2] negligible, if any.
n.d. — no data.

Source: 1977, 1980, 1985: I.R. Chernyy, Proizvodstvo sырya dlya neftekhimicheskikh sintezov. Moscow, Khimiya, 1983, p. 11; 1960, 1965, 1970, 1975: A.I. Rabkina, et al., Ekonomicheskiy problemy perspektivnogo razvitiya neftekhimicheskoy promyshlennosti. Moscow, Khimiya, 1979, p. 106; 1970, 1975, 1979: G.M. Kaviev, et al., Perspektivy proizvodstva i ispol'zovaniya etana v narodnom khozyaystve. Moscow, TsNIITENeftekhim, 1980, p. 7.

Thus, petrochemcial feedstocks comprised 5.6 percent of refinery throughput in 1980,[5] or some 25–26 million tons. This represents about three-fourths of the industry's petroleum requirements, with the remainder used as fuel. Thus, in addition to the 25–26 million tons of petroleum liquids used for feedstocks, another 7 million tons or so were used as fuel. In total then, petrochemical usage accounted for about 8 percent of Soviet petroleum consumption in 1980; however, these 32–33 million tons of feedstocks represented some 13–14 percent of all *light* petroleum products produced, because the output mix of Soviet refineries is dominated by heavy

[4] Matthew J. Sagers and Albina Tretyakova, "Constraints in Gas for Oil Substitution in the USSR: The Oil Refining Industry and Gas Storage," Soviet Economy, vol. 2 No. 1 (January-March, 1986), pp. 72-94; reference on p. 78.

[5] V.A. Proskuryakov and V.I. Klimenko, "Vazhneyshiye problemy nauchno-tekhnicheskogo progressa v neftekhimicheskoy promyshlennosti," in Neftekhimiya. Leningrad; Nauka, 1985, pp. 3–6; reference on p. 4.

products.[6] The bulk of these petroleum liquids are used for manufacturing olefins and aromatics.

IV. Development of the Industry

The Soviet petrochemical industry is relatively new, dating really only from the 1950's. Although some use had been made of petroleum-based chemical synthesis in the 1930's and 1940's, this was extremely limited, and the use of petrochemicals on a significant scale came only after World War II.

Early petrochemical developments in the 1950's focused upon production of synthetic ethanol (ethyl alcohol) from ethylene for butadiene manufacture, one of the principal monomers in synthetic rubber. It was not until the 1960's that the industry began to expand and diversify to supply a wider variety of intermediates to a broader range of synthetic materials industries. Its expansion and diversification continued through the 1970's, primarily based on imported equipment and designs (see below). But the industry is still small compared to that in other industrial countries.

A. EARLY ETHANOL PHASE

The USSR's first large-scale petrochemical plants, constructed in the 1950's, produced synthetic ethyl alcohol (ethanol) from ethylene in refinery gases. This early ethanol phase included the construction of synthetic alcohol plants at Sumgait (1952), Orsk (1955), Ufa (first section in 1956, second in 1962), Saratov (1957), Novokuybyshevsk (first section in 1957, second ethanol section in 1963), and Groznyy (first section in 1958, second in 1964) (Figure 1).

[6] Matthew J. Sagers and Albina Tretyakova, Restructuring the Soviet Petroleum Refining Industry, CIR Staff Paper No. 4. Washington, D.C.: Center for International Research, Bureau of the Census, 1985, p. 9.

60
20
60
100
140
180
180
160
40
20
40
0
1000
KMS
80
80

Ethanol was then the basic starting material for producing the butadiene monomer of synthetic rubber. Thus, ethanol had become an important chemical intermediate when Soviet production of synthetic rubber began on a large scale in the 1930's. At that time, production was based on the hydrolysis of wood, but this was soon surpassed in importance by ethanol production from agricultural raw materials (grain and potatoes).[7] However, the growing demand for synthetic rubber could not be met from agricultural products, and this triggered the post-war transition to the derivation of ethanol from petroleum.

Synthetic ethanol production grew rapidly in the 1950's, from 0.1 million decaliters in 1950 to 41.3 million in 1960 (Table 2). However, growth slowed in the 1960's, and then leveled off in the 1970's. Non-synthetic production evidently collapsed after 1975, and even synthetic production has been affected. Production in 1980 was only 142.2 million decaliters, of which 92.4 million, or 65 percent, were synthetic (petroleum-based) (Table 2).

TABLE 2.—PRODUCTION OF ETHYL ALCOHOL (ETHANOL)

[million decaliters]

	1940	1950	1955	1958	1960	1965	1970	1975	1980	1981	1982	1983	1984
All ethanol	89.9	73.0	n.d.	163.9	170.7	211.1	275.0	[1] 297.0	142.2	n.d.	n.d.	n.d.	n.d.
Synthetic (a)	([2])	0.1	5.3	26.5	41.3	76.0	90.0	95.0	92.4	92.2	92.5	89.8	89.7
Other (b)	89.9	72.9	n.d.	137.4	129.4	135.1	185.0	[1] 202.0*	49.8	n.d.	n.d.	n.d.	n.d.

[1] Planned.
[2] No production.
n.d.—No data.

(a) Petroleum-based.
(b) Derived from agricultural products and wood.

Source: Synthetic output, 1965-1980: L.A. Kostandov et al., Razvitiye khimicheskoy promyshlennosti v SSSR, Vol. 2. Moscow: Nauka, 1984. p. 197; synthetic output, 1981-1984: U.N. Economic Commission for Europe, Annual Review of the Chemical Industry. Geneva: Annual; percent synthetic, 1980: Kostandov et al., Vol. 1, 1984, p. 183; synthetic and other, 1940-1965: G.F. Borisovich, Ekonomika promyshlennosti sinteticheskogo kauchuka. Moscow: Khimiya, 1980. pp. 62-63; synthetic output, 1955: E.S. Savinskiy, Khimizatsiya narodnogo khozyaystva i razvitiye khimicheskoy promyshlennosti. Moscow: 1978. pp. 24-25; all ethanol and other, 1970-1975: V.M. Bushuyev, Khimicheskaya industriya v svete resheniy XXIV s'yezda KPSS. Moscow: Khimiya, 1973. pp. 144-145.

The declining importance of ethanol was due to technological changes in the synthetic rubber industry. In the early 1960's, processes to produce butadiene directly from butane and isobutane, bypassing the ethanol stage, began to be introduced, greatly lessening the need for ethanol. Thus, whereas 94.5 percent of synthetic rubber was derived from ethanol in 1960, only 15.5 percent was in 1970, and only 9 percent in 1980.[8] Ethanol remains a major petrochemical intermediate, however, with important uses in the paint and lacquer industry, pharmaceuticals, and in the production of photographic films, but even by the late 1970's, 60 percent of ethanol still was being used for producing butadiene.

B. THE ETHYLENE CHAIN: BACKBONE OF THE INDUSTRY

Ethylene is the single most important building block in petrochemical synthesis; it remains the pre-eminent base material, both in terms of the range of resulting end-products and in overall

[7] Matthew J. Sagers and Theodore Shabad, "Synthetic Rubber:" Chapter 7 of a forthcoming book on the Soviet chemical industry, 1986b.
[8] Sagers and Shabad, 1986b.

volume utilized. It serves as the base material for producing the three major thermoplastics, as well as synthetic rubber monomers, anti-freeze mixtures, etc.

In 1985, Soviet production of ethylene totalled 2.667 million tons, nearly double what it was in 1975, and 50 percent greater than in 1980 (Table 3). The large increase since 1975 has been due to the introduction of several large-capacity new plants in recent years, many of which have been imported (see below). Despite this recent expansion, ethylene production in 1985 was still less than 20 percent that of the United States, and before 1970, Soviet ethylene production was very limited, increasing from a miniscule 147,000 tons in 1960 to only 799,000 tons by 1970 (Table 3).

TABLE 3.—PRODUCTION OF OLEFINS, AROMATICS AND METHANOL

[Thousand tons]

	1960	1965	1970	1975	1980	1981	1982	1983	1984	1985
Olefins:										
Ethylene	147	480	799	1,366	1,773	2,093	2,132	2,267	2,543	2,667
Propylene	23	116	302	580	824	919	981	1,035	1,098	1,177
Aromatics:										
Benzene	506	697	1,036	1,427	1,644	1,698	1,690	1,853	1,956	1,971
Xylenes	42	94	214	327	459	468	409	559	849	937
Methanol	231	482	1,004	1,447	1,900	2,030	1,989	2,174	2,467	2,850

Sources: Statisticheskiy yezhegodnik stran-chlenov Soveta Ekonomicheskoy Vzaimopomoshchi (SEV). Moscow: SEV, 1986, pp. 96–97; 1976, p. 97. Narodnoye khozyaystvo SSSR v 1985 godu, statisticheskiy yezhegodnik. Moscow: Finansy i statistika, 1986, p. 146. Chernyy, 1983, p. 31.

The Soviet Union's first production of ethylene on anything approaching an industrial scale occurred in the 1950's, based on refinery gases, to make ethanol (see above). The first major ethylene-to-ethanol unit was inaugurated in 1952, at Sumgait, and others quickly followed (see above). Through the 1950's and into the 1960's, ethanol production was the major use of ethylene (Table 4). However, after having been oriented almost exclusively towards ethanol, ethylene production quickly changed direction in the 1960's, mainly towards polyethylene (a major thermoplastic), but also towards ethylene oxide (for glycol production), ethylbenzene (formed by reacting ethylene with benzene and used for styrene production), and the synthesis of vinyl chloride (from ethylene dichloride) and acetaldehyde; the use of ethylene for ethanol declined from about 70 percent in 1960 to 8.8 percent by 1980, while its use for polyethylene rose rapidly, from less than 1 percent in 1960 to 28.8 percent by 1970, and 45.6 percent by 1980 (Table 4).

TABLE 4.—STRUCTURE OF ETHYLENE AND PROPYLENE CONSUMPTION

[in percent of total]

	1958	1959	1963	1966	1970	1975	1980
A. Ethylene							
Ethanol	69.2	78.0	67.0	61.0	45.3	23.1	8.8
Polyethylene	0.4	[2]	11.0	14.1	28.8	29.5	45.6
Ethylbenzene (styrene)	5.5	3.6	5.5	7.2	3.6	9.5	7.5
Acetaldehyde	[2]	[2]	[2]	[2]	5.0	9.7	9.3
Ethylene oxide (glycol)	12.7	9.3	9.7	6.0	n.d.	n.d.	n.d.
Others	11.2	9.1	6.8	11.7	17.3	28.2	28.8

TABLE 4.—STRUCTURE OF ETHYLENE AND PROPYLENE CONSUMPTION—Continued

[in percent of total]

	1958	1959	1963	1966	1970	1975	1980
Ethylene dichloride	8.5	7.3	5.3	8.9	n.d.	n.d.	n.d.
				1960	1970	1975	1980 [1]
B. Propylene:							
Isopropylbenzene (phenol/acetone)				63.0	49.8	35.6	n.d.
Isopropyl alcohol				35.0	16.3	3.9	n.d.
Polypropylene				=	1.5	7.8	n.d.
Butanol				=	13.2	19.8	n.d.
Allyl chloride (glycerin) [2]				=	6.6	n.d.	n.d.
Acrylonitrile				=	5.6	n.d.	n.d.
Propylene oxide				=	4.7	n.d.	n.d.
Others (including methylstyrene)				2.0	2.3	26.9	n.d.

[1] Source lists 1980, but provides no data.
[2] Negligible, if any production from ethylene, propylene.
n.d. no data.

Source: Chernyy, 1983, p. 22 for 1970, 1975, and 1980.
L.A. Kostandov et al., 50 let khimicheskaya nauk i promyshlennost'. Moscow: Khimiya, 1967, p. 191 for 1958 and 1963.
N.P. Fedorenko, Voprosy ekonomika promyshlennosti organicheskogo sinteza. Moscow: Nauka, 1967, p. 121 for 1966 and 1959.

But in establishing these new petrochemical-based synthetic materials industries, much of the equipment had to be imported. Currently, well over half of the USSR's acrylic fibers and the acrylonitrile intermediate is produced on imported equipment, about three-quarters of the caprolactam, the intermediate for polyamide fibers (nylon), and almost all of polyester fibers. Among the major thermoplastics, the production of polyethylene is nearly totally dependent upon imported equipment, and about 85–90 percent of polypropylene, some 60–65 percent of polystyrene, and nearly 50 percent of polyvinyl chloride is produced on imported equipment.[9]

The USSR's first polyethylene-oriented ethylene plants were installed in the early 1960's, several of which were based on pyrolysis rather than the separation of refinery gases. Since then, most of new ethylene capacity has been based on pyrolysis, and this manufacturing process now dominates production. These early units were fairly small, but after 1965, larger pyrolysis units, with capacities of 60,000 and 100–120,000 tons, began to be introduced to support the expansion and diversification of ethylene-based synthesis.

The first significant polyethylene-oriented ethylene unit went into operation in 1961 at the Groznyy chemical plant, and the second (based on the pyrolysis of hydrocarbon gases) opened at Salavat in 1962 (Figure 1). Another early pyrolysis-type ethylene unit opened at the Novokuybyshevsk synthetic alcohol plant in 1963. During the 1960's the Ufa petrochemical complex also began producing polyethylene, and acquired several additional ethylene units, of which at least one is a 60,000 ton pyrolysis facility.[10]

The production of ethylene/polyethylene expanded to four other refining and petrochemical centers in the late 1960's: Gur'yev in Kazakhstan, Novopolotsk in Belorussia, Sumgait in Azerbaijan,

[9] Matthew J. Sagers and Theodore Shabad, "Petrochemicals," Chapter 6 of a forthcoming book on the Soviet chemical industry, 1986a.
[10] Sagers and Shabad, 1986a.

and Kazan' (Figure 1). In a somewhat different line of development, the Omsk synthetic rubber plan began producing acetaldehyde from ethylene in 1970, implying some ethylene manufacture there.

Production of ethylene/polyethylene began at the Gur'yev refinery in 1966, based on the separation of refinery gases, with additional capacity being installed in the early 1970's. An ethylene unit, based on refinery gases, went in with Novopolotsk's first polyethylene plant in 1968, and an additional ethylene/propylene separation unit, with a capacity of 60,000 tons per year, was installed at Novopolotsk in 1970 by a British firm. This apparently was the first use of imported ethylene equipment in the USSR. Another 60,000 ton unit was installed at Novopolotsk during the early 1970's, although of the pyrolysis type.[11] Sumgait's second ethylene unit was installed in 1967, the first had been installed in 1952 to support ethanol synthesis (see above), and a polyethylene facility was added to the Kazan' organic synthesis plant in 1965, an expansion which included the installation of an ethylene unit. A second ethylene unit was added in 1967, and ethylene production continued to expand at Kazan' through the 1970's and early 1980's, with a 100,000 ton ethylene unit (apparently Soviet-made) starting up in 1975, and another unit, a 200,000 ton plant imported from Japan, being added in 1982.

Despite the large amount of ethylene being produced at Kazan', it was inadequate to support the plant's rapidly expanding polyethylene output, which in the late 1970's had reached about 30 percent of all Soviet production, or some 150,000 tons. Ethylene was also needed to supply the 30,000 ton ethylene glycol and 60,000 ton ethylene oxide units completed in the late 1970's, using Japanese equipment.

Kazan's additional ethylene needs led to the construction of an ethylene pipeline from the Nizhnekamsk petrochemical complex in 1976; other pipeline segments were added during 1977 to carry ethylene southward from Nizhnekamsk to Ufa, Sterlitamak, and Salavat, creating an ethylene pipeline network.[12] The USSR supplied the pipe, but the design and engineering, as well as ancillary equipment, were provided by several Western firms.[13] The ethylene is used for the production of polyethylene at Ufa and Salavat, and vinyl chloride at Sterlitamak.

Two other domestic 60,000 ton ethylene units were installed in the 1970's, one at Perm' in 1975 and the other at Angarsk in 1977 (Figure 1), while a 450,000 ton ethylene plant, the USSR's largest, began operations in mid-1976 at the huge Nizhnekamsk petrochemical complex. This unit supplies ethylene by pipeline for processing activities at Kazan', Ufa, and Sterlitamak (see above), as well as being utilized locally for producing ethylbenzene and styrene. Units for producing 200,000 tons of ethylene oxide and 7,500 tons of ethylene glycol, both using West German equipment, are under construction.

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[11] Sagers and Shabad, 1986a.

[12] Theodore Shabad, "News Notes," Soviet Geography, Vol. 18 no. 10 (December, 1977), p. 779.

[13] CIA (Central Intelligence Agency), Soviet Chemical Equipment Purchases from the West: Impact on Production and Foreign Trade. ER-78-10554, October, 1978.

The large ethylene plant at Nizhnekamsk is said to be of domestic manufacture, built under license from Tokyo of Japan using a Lummus process;[14] it carries the Soviet designation EP-450. However, most of the components used were actually purchased from abroad rather than manufactured domestically, so the unit also is referred to as "imported".[15]

In addition to ethylene, the Nizhnekamsk olefin plant produces 200,000 tons of propylene, 54,000 tons of butadiene, and 180,000 tons of benzene as co-products. The benzene unit is an add-on using Japanese equipment (pyrotol process); an identical facility was completed earlier at Kazan'.

Large-capacity domestic ethylene units also have been developed in recent years, although some parts (specifically the furnace assemblies) come from Czechoslovakia.[16] These units, known as EP-300's, have capacities of 300,000 tons of ethylene, but also yield about 144,000 tons of propylene and 40,000 tons of butadiene per year. The first of these was introduced in 1978, at Lisichansk, and three more of these units were constructed in the early 1980's, one at the Novo-Gor'kiy refinery at Kstovo in 1981, one at the Angarsk refinery in 1982, and another at Salavat in 1984 (Figure 1). The construction of two others began during the 11th Five-Year Plan, at Novokuybyshevsk and Sumgait; the Sumgait unit was scheduled to begin operations in 1986.

In addition to these domestically-manufactured units, a large ethylene-propylene plant purchased from West Germany went into operation at Budennovsk, in the North Caucasus, in 1980 (Figure 1). The plant has a capacity of 250,000 tons of ethylene, 125,000 tons of propylene, and 100,000 tons of benzene, and supplies a new polyethylene plant. An identical West German ethylene-propylene plant is under construction at Kalush in the western Ukraine to support its large vinyl chloride production. Ethylene now is being supplied to Kalush via a pipeline from Leninvaros in Hungary, which has been in operation since 1974. The Kalush olefin plant is scheduled to begin operating in 1986, and plans call for the direction of flow in the ethylene pipeline to be reversed in 1987, supplying ethylene and propylene to Hungary.[17]

1. Propylene

One of the main co-products of ethylene manufacture is propylene, the industry's second most important monomer. Production in 1985 was 1.177 million tons, up nearly 43 percent from 1980, and double what it was in 1975 (Table 3). Like ethylene, the principal source of propylene in the USSR was at first refinery gases, but now is derived mostly from pyrolysis. The main propylene-producing centers are the large pyrolysis units previously mentioned, which jointly produce ethylene and propylene. Nizhnekamsk produces about 200,000 tons per year, Lisichansk, Novo-Gor'kiy, Angarsk, and Salavat produce about 144,000 tons per year, and the Budennovsk plant produces about 125,000 tons of propylene per

[14] Neftepererabotka i Neftekhimiya, no. 8 (1981), p. 37; no. 7 (1985), p. 25.
[15] CIA, 1978, p. 25; Khimicheskaya Promyshlennost', no. 12 (1984), p. 17.
[16] Neftepererabotka i Neftekhimiya, no. 7 (1981), p. 41.
[17] Sagers and Shabad, 1986a.

year (see above). The smaller pyrolysis units also yield some propylene.

The demand for propylene in the USSR was fairly small until the development of the cumene method for producing phenol and acetone, two widely used intermediates; this quickly became propylene's most important use. By 1959, two-thirds of propylene output was used for making cumene (isopropylbenzene). The production of methylstyrene, an important monomer for synthetic rubber manufacture, began in the late 1950's in a process using propylene, diversifying propylene consumption somewhat through the early 1960's (Table 4). Since then, a variety of other uses have developed, such as polypropylene (a thermoplastic), acrylonitrile (for making fibers), butanol, and propylene oxide (Table 4).

C. AROMATICS

Aromatic hydrocarbons are very important base materials in heavy organic synthesis, second only to the olefins, and are also key blending components in high-octane motor fuels. The simplest, but most important aromatic, is benzene; the three isomers of xylene also are important, while toluene, the remaining major aromatic, is used mostly in motor fuels, although a significant amount is used to produce benzene. Considerable amounts of aromatics also are exported; Soviet exports of aromatics were over 478,000 tons in 1985, nearly three-quarters of which were xylenes.[18]

The production of aromatic hydrocarbons has grown rapidly in the USSR during the last 25 years: benzene production has increased nearly four-fold since 1960, from 506,000 tons to 1,971,000 tons in 1985, and production of xylenes has increased by over 22 times, from a mere 42,000 tons in 1960 to 937,000 tons in 1985 (Table 3). Although no tonnage figures are available, toluene output increased 8.2 times between 1960 and 1980,[19] suggesting a level of production intermediate between benzene and the xylenes. However, aromatics production is still relatively low by U.S. standards; Soviet benzene production is about 40 percent that of the U.S., while xylenes output is only about 15 percent of U.S. production.

Most of the USSR's aromatics are now obtained from the catalytic reforming of gasoline fractions; their extraction from coking ovens is of secondary importance; in the 1970's, nearly 60 percent of benzene, and 90 percent of toulene and xylenes, were produced from catalytic reforming.[20] Thus, aromatics production tends to be concentrated at a few petroleum refineries which have large catalytic reforming units equipped with aromatics extraction. This is known to occur at Ufa, Omsk, Novopolotsk, Angarsk, Salavat, Kirishi, Kremenchug, Novokuybyshevsk and Volgograd, and probably at Baku/Sumgait and Perm' (Figure 1).

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[18] Vneshnyaya Torgovlya SSSR v 1985 godu. statisticheskiy sbornik. Moscow: Finansy i statistika, 1986, p. 26.

[19] I.R. Chernyy, *Proizvodstvo syr'ya dlya neftekhimicheskikh sintezov*, Moscow. Khimiya, 1983, p. 187.

[20] Sagers and Shabad, 1986a.

1. Benzene

Currently in the USSR, 90 percent of benzene is used for producing ethylbenzene (used for making styrene), phenol, and caprolactam (the intermediate for polyamide fibers); nearly half of benzene output is devoted to ethylbenzene manufacture alone (Table 5). Most of the remainder is used in the production of other chemicals, including maleic acid/anhydride, adipic acid, and alkylbenzene. Thus, the chemicals industry itself accounts for practically all of Soviet benzene consumption. This represents a considerable change in benzene consumption patterns since 1959, when the chemical industry used little more than a quarter of benzene output, and within the chemical industry itself, phenol production was then the major consumer, while ethylbenzene accounted for less than 10 percent of all benzene usage (Table 5).

TABLE 5.—STRUCTURE OF BENZENE CONSUMPTION

(In percent of total)

	1959	1965	1970	1980	1980
Phenol (cumene)	18.6	49.5	42.7	33.9	27.6
Ethylbenzene	8.7	29.9	16.2	38.6	48.3
Caprolactam	(1)	(1)	11.0	16.0	14.1
Cyclohexane	(1)	4.3	3.0	1.6	0.9
Maleic anhydride/acid	(1)	3.0	1.0	0.5	1.0
Others	72.7	13.3	26.1	9.4	8.1

1 Production negligible, if any.

Sources: N.P. Fedorenko, Ekonomika promyshlennosti sinteticheskikh materialov. Moscow, Ekonomicheskoy literatury, 1961, p. 163, for 1959. Chernyy, 1983, p. 188 for all other years.

Until the 1960's, coke-chemistry was nearly the sole source of benzene; in 1959, 99 percent of benzene came from coking, and only 1 percent from petroleum. This was because the USSR's first catalytic reformer was not inaugurated until 1958, at Ufa, and this was only an experimental unit; the first industrial unit did not start up until 1962, at Novokuybyshevsk.[21] Even by 1965, only 9 percent of benzene was derived from petroleum, and in 1970, 36.8 percent. But by the mid-1970's, catalytic reforming had become the major source of benzene, accounting for nearly 60 percent of output. Still, unlike many of the other organic chemicals, where petroleum raw materials predominate, a large share of benzene still comes from coke, 37.9 percent in 1980.[22]

Since the mid-1970's the share of benzene coming from catalytic reforming has diminished slightly due to the expansion of the pyrotol process, and in 1980, 17.3 percent of benzene was obtained as a byproduct of ethylene manufacture during pyrolysis.[23] The EP-450 unit at Nizhnekamsk is capable of producing 180,000 tons of benzene a year, the Kazan' unit, 160,000 tons, and the unit at Budennovsk, 100,000 tons. A similar unit, of 100,000 tons is approaching completion at the new Kalush olefin plant.[24] Unit 1986, all of the

[21] Sagers and Tretyakova, 1985, p. 19.
[22] Chernyy, 1983, p. 187.
[23] Chernyy, 1983, p. 187.
[24] Sagers and Shabad, 1986a.

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units employing this process were imported, but a domestically produced unit just was installed at Novo-Gor'kiy, operating off its EP-300. It has a capacity of 130,000 tons.

The major production center for the limited amount of petroleum-derived aromatics in the 1960's was Ufa, and it is probably still the largest, because of a recent expansion. A very large catalytic reforming unit was completed in 1983–1984, of French manufacture; it has a capacity for producing 125,000 tons of benzene, as well as 165,000 tons each of p-xylene and o-xylene.[25] An identical unit to the large benzene/xylene complex at Ufa was completed at Omsk, at about the same time (1983–1984). Like Ufa, Omsk also had some previously existing aromatics capability, and with the commissioning of these large new units, Ufa and Omsk are reportedly the largest centers of aromatic hydrocarbon production in the world. These two units are part of a complicated compensation deal with France, and some of the aromatics being exported (see above) represent product pay-back for the imported equipment.[26]

Two other large (120–125,000 ton) benzene units were completed recently, using Japanese equipment, one at Krasnodar in the late 1970's, and the other at Novopolotsk, in 1985. These are probably reformers and not pyrotol units.[27]

2. Xylenes

Xylenes production remained very small until the widespread use of catalytic reforming in the Soviet petroleum refining industry in the 1960's and 1970's (Table 3). Before that, xylenes were produced mainly from the distillation of hydrocarbon fractions in coal-tar. Even so, as early as 1963, 74.2 percent of xylenes were petroleum-based, and currently, 99 percent of xylenes are produced from petroleum, 98 percent from catalytic reforming alone.

The main uses for xylenes are in the production of resins (from phthalic anhydride), synthetic fibers, and as a solvent, although this varies somewhat among the three isomers: p-xylene (para-xylene), o-xylene (ortho-xylene), and m-xylene.

Para-xylene, the most important of the three, is used principally for the production of dimethyl terephthlalate and terephthalic acid (the intermediates for making polyester fibers). Production of p-xylene has grown extremely rapidly, increasing 50 times between 1960 and 1980,[28] with most of the growth occurring just since 1975, associated with the installation of several large units (see below). The first production of the p-xylene isomer in the USSR (at least from petroleum) occurred in 1959 at the Novokuybyshevsk oil refinery, which was even before its first catalytic reformer was installed (see above). The largest p-xylene plants in the USSR are the new units at Ufa and Omsk, which have capacities of 165,000 tons each (see above). Other major plants include Kirishi and Novopolotsk (Figure 1). Before the inauguration of the Ufa and Omsk units in 1984, Kirishi had the largest xylenes plant in the country. It was completed in 1976 using Japanese equipment and produces

[25] Theodore Shabad, "News Notes," Soviet Geography, Vol. 25 no. 7 (September 1984), p. 547.
[26] Jeanine D. Braithwaite, "Soviet Foreign Trade in Chemicals," Chapter 11 of a forthcoming book on the Soviet chemical industry, 1986.
[27] Sagers and Shabad, 1986a.
[28] Chernyy, 1983, p. 187.

both p-xylene and o-xylene. The capacity for each isomer is 60,000 tons per year. Novopolotsk's xylene plant was installed in 1970, and is of British manufacture. Initially it had a capacity of 44,000 tons per year, but is much greater now after being expanded in 1976.

Ortho-xylene is second in significance among the isomers. O-xylene output increased nearly 14 times between 1960 and 1980.[29] Its first production (from petroleum) was at the Novokuybyshevsk refinery in 1963. It is used mainly (as is m-xylene) to produce p-xylene through isomerization. Another important use is in the production of phthalic anhydride, the intermediate for alkyd resins manufacture. Through the mid-1960's, phthalic anhydride was produced almost entirely from naphthalene, from the coke-chemical industry, but the growing shortage of naphthalene led to the use of o-xylene for phthalic anhydride synthesis. Its production from o-xylene began on a significant scale in the mid-1960's at Angarsk, and several large units employing this process have been installed since.

The third isomer, m-xylene, is not used much directly in chemical synthesis. Its main use is as a high-octane gasoline component, although some m-xylene is utilized for isomerization to p-xylene and in the production of isophthalic acid.

D. METHANOL (METHYL ALCOHOL)

Methanol has become a large-volume basic chemical in the USSR, with a wide range of applications; a significant amount is exported (710,482 tons in 1985).[30] Production in 1985 was 2.850 million tons (Table 3), an increase of 50 percent since 1980, and over 2.8 times since 1970. This reflects a Soviet program to use utilize more comprehensively the country's large natural gas resources domestically and for exports.

Some 50 percent of all Soviet methanol is used for the manufacture of formaldehyde (for resins), 11 percent for isoprene synthetic rubber, and 9 percent for methylamine. A variety of other chemicals are derived from methanol, and it also is used in making photographic materials and as a paint and lacquer solvent. Unlike many of the other petrochemicals, methanol's consumption pattern has not changed a great deal in the last two decades. In 1965, 49.3 percent was used for formaldehyde, 10.4 percent for isoprene synthetic rubber, 5.2 percent for other chemical, uses, and 35.1 percent for nonchemical uses (e.g., export, gas industry); in 1959, 46.8 percent was used for formaldehyde and 18.7 percent for other chemical products.[31]

Production of methanol began in the early 1930's from the destructive distillation of wood, mostly to supply the formaldehyde needed for resins. But the increasing needs of the early Soviet plastics industry for formaldehyde triggered a change from wood to the "synthetic" production of methanol in the mid-1930's, using the catalytic reaction of carbon monoxide and hydrogen under pressure. The raw material used was water-gas or synthesis-gas, a mix-

[29] Chernyy, 1983, p. 187.
[30] Vneshnyaya Torgovlya SSSR v 1985 godu, p. 26.
[31] Sagers and Shabad, 1986a.

ture of carbon monoxide and hydrogen obtained from blowing steam over red-hot coke or coal. This process was first employed at Novomoskovsk, in Tula Oblast, in 1934. Several methanol plants of this type were constructed during the next two decades, and until the early 1960's, most methanol was derived from water-gas; in 1959, 99 percent of production was based on coal or coke.

However, a rapid transition to natural gas began in the 1960's, and it now represents the main raw material for methanol production. Although no methanol was produced from natural gas in 1959, by 1965, it accounted for 49 percent of production, and by the mid-1970's, 69.8 percent. Currently, the share of natural gas-based methanol is around 97 percent.[32]

The transition occurred as the older methanol plants converted to natural gas and several new plants were built. The whole range of chemicals produced at Novomoskovsk and Shchekino, in Tula Oblast, based on synthesis-gas, including methanol, began to be converted to natural gas in the 1950's, and methanol production at Severodonetsk, in the eastern Ukraine, associated with coke-based ammonia synthesis, also converted to natural gas. Severodonetsk is now a large producing center, particularly of methanol for export. Several new plants were built along natural gas pipelines in the 1960's and 1970's, generally in conjunction with ammonia synthesis; these include Jonava, in Lithuania, and Novgorod, where production began in the late 1960's, and Nevinnomyssk, which acquired a methanol unit in 1976 (Figure 1).

The USSR's principal methanol plants, though, are very recent additions. Both use British equipment, and have production capacities of 750,000 tons per year, making them the largest in the world. The first of these, at Tomsk, yielded its first product in 1983, and reached design capacity in early 1984. The second plant, at Gubakha in Perm' Oblast, came on line in 1984 and reached production capacity a year later. Each plant now reportedly produces nearly a third of Soviet methanol output. Like the aromatics, both of these large plants are part of compensation deals in which part of the output is exported to pay for the equipment.[33]

V. 12th Five-Year Plan: Targets and Prospects for Fulfillment

Expanding production of these key primary petrochemicals is to continue at a fairly rapid rate, largely driven by the increasing demand for modern plastics and fibers. During the 12th Five-Year Plan (1986–1990), the production of chemical fibers is to increase by nearly 33 percent, while plastics output is to increase by about 40 percent.[34] To support this expansion, benzene output is to increase by 50 percent, and that of ethylene and propylene by 40 percent.[35] No information is available on what is planned for xylenes or methanol output, but it would probably be in this same range, although in both cases, a surprisingly large proportion of output is

[32] Sagers and Shabad, 1986a.
[33] Braithwaite, 1986.
[34] Pravda, June 19, 1986; Sotsialiticheskaya Industriya, March 9, 1986.
[35] N.B. Lemayev, "Zadachi nauchno-tekhnicheskogo progressa v. neftepererabatyvayuschchey i neftekhimicheskoy promyshlennosti i mesto v ikh reshenii kataliza tseolitakh," Neftekhimiya, no. 2 (1986), pp. 147–150; reference on p. 147.

exported: 35 percent of xylenes and 25 percent of methanol (see above). For benzene, the growth target implies an increment in production of about 1 million or so, equivalent to 6–8 new production units, and for ethylene and propylene, the planned increment is also about 1 million tons, representing 3–4 new production units.

A. EQUIPMENT AVAILABILITY

One problem which may prevent the fulfillment of these targets is a shortage of equipment. The Soviet chemical engineering industry has long had serious shortcomings,[36] and does not seem capable of delivering this much equipment, particularly for the aromatics. The sector had been a high priority for expansion earlier because of the chemicalization drive launched under Khrushchev, and therefore had been one of the most dynamic of the individual machine-building sectors in the 1960's. Even at that time it was not equal to the challenge, however, and large amounts of chemical equipment had to be imported to support the chemicalization drive.[37] Since 1970, the priority of the sector (in terms of investment share) has been declining.

Furthermore, since the 1970's, the USSR's mounting energy problems have led to a heightened emphasis on the oil and gas sectors,[38] resulting in a high rate of growth in the production of oilfield and drilling equipment, and since it is produced in the same ministry as chemical equipment (Ministry of Chemical and Petroleum Machine-Building), resources undoubtedly have been shifted into oil and gas equipment from chemical machine-building. For example, one of the leading producers of chemical equipment, the "Frunze" plant in Sumy, became embroiled in the high priority crash program to supply compressors for gas pipelines in the early 1980's,[39] and now it has been designated to produce gas-lift equipment for the oil industry, seen as the key to improving performance in the crucial West Siberian fields.[40]

Weaknesses in the domestic chemical machine-building industry were the principal reason for such a large proportion of the petrochemical industry's new production capacity in the 1970's being comprised of imported equipment. The imported Western ethylene equipment installed at Novopolotsk, Kazan', Nizhnekamsk, and Budennovsk (see above) comprised about 18 percent of total installed ethylene capacity in the USSR in 1985,[41] and may have produced

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[36] Ronald Amann, "The Chemical Industry: Its Level of Modernity and Technological Sophistication," in Ronald Amann, Julian Cooper and R.W. Davies (eds.), *The Technological Level of Soviet Industry*. New Haven and London: Yale University Press, 1977, pp. 227–327.

[37] Amann, 1977.

[38] Thane Gustafson, "The Origins of the Soviet Oil Crisis: 1970–1975," Soviet Economy, Vol. 1 no. 2 (April–June, 1985), pp. 103–135; Ed A. Hewett, Energy, Economics, and Foreign Policy in the Soviet Union. Washington, D.C.: Brookings Institution, 1984. Thane Gustafson, "Soviet Adaptation to Technological Pressures: The Case of the Oil and Gas Sector, 1975–85," in Philip Joseph (ed.), Adaptability to New Technologies of the USSR and East European Countries. Brussels: NATO Colloquium, April, 1985, pp. 151–197.

[39] Thane Gustafson, "The Soviet Response to the American Embargo of 1981–1982: The Case of Compressors for the Export Gas Pipeline," in Gordon B. Smith (ed.), The Politics of East-West Trade. Boulder, Colo.: Westview Press, 1984, pp. 129–141.

[40] Matthew J. Sagers, "Recent Developments in the Soviet Oil, Coal, and Electric Power Industries," PlanEcon Long-Term Energy Outlook, Fall, 1986b.

[41] Sagers and Shabad, 1986a.

as much as 30 percent of all Soviet ethylene in the mid-1980's, and a similar share of propylene.[42] The Western benzene units operating at Nizhnekamsk, Budennovsk, Kazan', Ufa, Omsk, Krasnodar, and Novopolotsk account for around 48 percent of Soviet benzene production, and the production of xylenes is even more dependent upon Western equipment; the units installed at Novopolotsk, Kirishi, Ufa, and Omsk produce over 90 percent of all Soviet xylenes. The two big imported Western methanol units at Tomsk and Gubakha alone produce nearly two-thirds of Soviet output.

These high shares of output indicate the industry's considerable dependence upon imported equipment, symptomatic of several other sectors of the chemical industry. Therefore, since there is apparently no provision for imported equipment in the 12th Five-Year Plan (no new equipment contracts have been signed), it is uncertain if sufficient domestic equipment supplies can be obtained. This then could lead to insufficient basic petrochemicals to support the expansion of synthetic materials and in turn, jeopardize the industrial modernization programs in machine-building and construction.

However, it does appear that the goal for olefins is within reach, as two plants have been under construction for some time, at Novokuybyshevsk and Sumgait, and should be commissioned soon, while construction has already begun on a new unit at Tomsk.[43] These are all domestic EP-300s, and it appears that at least these units can be manufactured in sufficient quantities. But it is difficult to envision much new capacity for benzene, xylenes, and methanol without equipment imports from the West.

B. FEEDSTOCK AVAILABILITY

Another possible constraint in expanding petrochemical production is feedstock shortages. Although primary petrochemical production is to expand by some 40–50 percent, petrochemical feedstocks as a whole are to increase by only 20 percent between 1985 and 1990.[44] This is but one example of the overall emphasis in the Plan on raw material savings and greater efficiency in their use. The problem is that the exact source of these savings in feedstocks is not clear. In fact, feedstock shortages are already a problem for many petrochemical plants, and prospects are for the situation to become worse.

For example, in the key Volga-Urals region, less NGL is available from gas plants in the region for petrochemical synthesis because of the sharp decline in petroleum production, and therefore associated gas output, in the Volga-Urals region in the last decade. The same problem also has occurred in the North Caucasus. A new NGL pipeline from West Siberia to the Volga-Urals ws completed in 1985, which should help ease feedstocks problems there, and at Budennovsk, low-octane gasoline from the Groznyy refineries has had to replace local NGL feedstocks.

A serious feedstock shortage also is known to plague the Shevchenko plastics plant in Kazakhstan, one of the largest in the coun-

[42] Sagers and Shabad, 1986a.
[43] Sagers and Shabad, 1986a.
[44] Lemayev, 1986, p. 147.

try. The nearby Kazakh gas plant has been unable to supply enough ethane for ethylene manufacture because of the decline in local oil and associated gas output, so styrene has to be brought in to run the plant.[45] The petrochemical operation at the nearby Gur'yev oil refinery, which is based on refinery gases, also has been suffering because supplies of local crude have not been available to maintain refinery throughout.[46]

Like Gur'yev, many of the older Soviet petrochemical plants utilize refinery gases for feedstocks. This includes plants such as Novokuybyshevsk, Salavat, Ufa, and Novopolotsk. Thus as refinery throughout fell in 1985 throughout the USSR due to the shortage of crude,[47] petrochemical production at these key plants probably was adversely affected. Although crude production has bounced back in 1986,[48] future output trends are highly uncertain. If Soviet crude petroleum production should decline significantly by 1990, leading to reduced refinery throughout, the availability of refinery gases for feedstocks could again be adversely affected. Also, naphtha supplies for pyrolysis and reforming will be affected by the overall availability of crude (which has become increasingly tight), as well as trends in the refinery sector for producing more light products per ton of crude refined (see above).

One potential source of feedstock savings lies in shifting the feedstock mix to lighter products because they yield more ethylene and other primary products, particularly given the considerable increase in Soviet NGL production in recent years.[49] Typically, the yield of desired products from ethane is about 80 percent, from LPG, 60–65 percent, from naphtha, 50–55 percent, and from gas-oil, 40–45 percent.

Most of the USSR's pyrolysis feedstocks are comprised of relatively heavy refinery liquids (naphtha and gas-oil). These accounted for about three-quarters of the total in 1980 (Table 1). Although some shift to the lighter feedstocks can be discerned, such as from gas-oil to naphtha and LPG to ethane (Table 1), this has been too limited to significantly increase yields and reduce overall feedstock needs.

Interestingly, the lighter products previously dominated petrochemical feedstock supplies, as the current predominance of naptha is fairly recent. Before the 1970's, when olefin production was small, the major feedstocks were NGL (LPG and ethane) and refinery gases. In 1960, they accounted for 79 percent, and in 1965, 78 percent, of feedstocks (Table 1). As late as 1970, naphtha comprised only 20 percent of all ethylene feedstocks. But as olefin production began to reach significant levels in the 1970's, naphtha came to dominate the feedstock pattern.

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[45] Theodore Shabad, "News Notes," Soviet Geography, Vol. 21 no. 3 (March, 1980), pp. 190–191; Vol. 24 no. 5 (May, 1983), p. 404.

[46] Sagers and Shabad, 1986a.

[47] "Soviet Union Starts Campaign To Upgrade Refineries," The Oil and Gas Journal, March 3, 1986, p. 26.

[48] "Significant Upturn in Soviet Oil and Coal Production Spells the Possibility of a Flood of Soviet Oil on the World Market in the Second Half of 1986," PlanEcon Report, Vol. 2 Nos. 29–30 (July 24, 1986).

[49] Matthew J. Sagers, Natural Gas Liquids and the Soviet Gas Processing Industry, CIR Staff Paper No. 14. Washington D.C.: Center for International Research, Bureau of the Census, 1986a.

This is just opposite global trends. During this same period, the world petrochemical industry has been rapidly switching from liquid to gaseous feedstocks. This is because the dramatic oil price increases in 1973 and 1979 affected chiefly the liquid oil products and made them relatively more expensive than gaseous hydrocarbons.[50] This change in feedstock base has resulted in a global redistribution of the petrochemical industry towards raw material locations. Whereas the oil-based feedstocks were available at refineries located in consuming areas, the gaseous feedstocks are available only at the source of raw materials (gas and oil fields). Thus, globally the industry has been shifting from its traditional locations in North America and Western Europe to the Middle East and other major gas producers (e.g., Saudi Arabia, Kuwait, Mexico, Indonesia).[51] Similarly, production has shifted *within* North America and Western Europe to raw materials (NGL) sites, such as Alberta, in western Canada, and Mossmorran, in Scotland.[52]

One reason for the USSR's increasing reliance on refined petroleum liquids is the relative underdevelopment of the gas processing industry in the USSR, with little of the available light hydrocarbons actually being extracted.[53] Another key problem in utilizing NGL in the Soviet petrochemical industry is its regional availability. This is because, in contrast to global trends, the Soviet petrochemical industry has remained concentrated in the Volga-Urals region, where it developed in the 1950's and 1960's, closely tied to refinery-based hydrocarbons, although local production from associated gas traditionally supplied a significant amount of NGL.[54] But hydrocarbon production has declined sharply in the Volga-Urals region since the 1970's, and this has greatly reduced the supply of local raw materials for feedstock use. In contrast, hydrocarbon production in West Siberia has soared. By 1985, West Siberia supplied 62 percent of Soviet oil and 58 percent of gas, while the Volga-Urals contributed 8 percent of gas (now largely high-sulfur Orenburg gas) and 23 percent of oil.[55] This compares with 1970, when the Volga-Urals produced 59 percent of Soviet oil and 9 percent of gas (which was then mostly associated gas). Thus, West Siberia is producing an increasing share of Soviet hydrocarbons and NGL, while there is a growing shortage for petrochemical use in the Volga-Urals region.

It was to partially rectify this problem that the 11th Five-Year Plan (1981–1985) included the construction of a NGL pipeline from West Siberia to the Volga-Urals. The pipeline, which was finished in 1985, carries natural gasoline from the gas plants in the West

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[50] OECD (Organization for Economic Cooperation and Development), Petrochemical Industry: Energy Aspects of Structural Change. Paris: DECD, 1985.

[51] J.T. Quant, London: Distribution of Petrochemicals Towards the 1990's: A View of a Producer. Shell Chemicals, 1981; United Nations, First World-Wide Study on the Petrochemical Industry: 1975–2000. New York: Internal Center for Industrial Studies.

[52] Keith Chapman, "Control of Resources and the Recent Development of the Petrochemical Industry in Alberta," The Canadian Geographer, Vol. 29 no. 4 (Fall, 1985), pp. 310–326; "Further Shakeout Expected in Europe's Ethylene Industry," Chemical and Engineering News, November 25, 1985, pp. 15–17.

[53] Sagers, 1986a.

[54] Sagers and Shabad, 1986a.

[55] Theodore Shabad, "News Notes," Soviet Geography, Vol. 27 no. 4 (April, 1986), pp. 248–267.

Siberian oil fields processing associated gas as well as stable gas condensate from the Urengoy gas field.[56]

Thus, in the USSR, the trend has been one of moving NGL to established petrochemical centers rather than shifting the industry to the new raw material sites. Although the Soviet petrochemical industry has been very slow in making the spatial shift to take advantage of the new feedstock materials, West Siberia has experienced some petrochemical development. Omsk has become a major petrochemical center (Figure 1), although it is largely organized around its huge oil refinery. But two other large West Siberian NGL-based petrochemical complexes, after lagging for many years, are now coming on line, although they are still not fulfilling initial Soviet expectations for the projects.

One of these is at Tobol'sk, where its first unit, a 3 million ton gas fractionator, began operations in 1984. Once envisaged as the USSR's largest synthetic rubber complex, its significance has become doubtful in recent years.[57] It produces individual paraffin hydrocarbons from NGL, supplied by the West Siberia—Volga-Urals NGL pipeline.[58] These were to be used for the production of synthetic rubber monomers (butadiene, isoprene), but these downstream production units still do not exist, so the feedstocks are shipped out to synthetic rubber plants in the European USSR. Plans also call for the eventual installation of an olefin plant. The other new petrochemical plant is at Tomsk. Its huge methanol and polypropylene units, installed in the early 1980's, are operating, but it does not yet have its own olefin production, and the propylene monomer is railed in for polymerization. A large 300,000 ton ethylene unit, to be based on NGL, is under construction, and is scheduled to produce its first output in 1987.

[56] Sagers, 1986a, pp. 43–44.
[57] Sagers and Shabad, 1986b.
[58] Sagers, 1986a, p. 41.

THE SOVIET CHEMICAL INDUSTRY: CHEMICALIZATION, CAPITAL, AND COMPENSATION

By Jeanine D. Braithwaite*

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Summary

The purpose of this article is to assess the Soviet chemical industry and to evaluate its potential for achieving the targets contained in the 12th Five Year Plan (1986–1990) and the Chemicalization Program. It seems unlikely that these performance targets will be fulfilled, due to the persistence of input supply bottlenecks and the dependency of the industry upon imported technology.

This article examines the key area of efficiency of factor utilization, primarily focusing on capital, the most important factor in chemical technology. The Soviet Union has experienced major problems with capital utilization in the chemical industry, due to input shortages, inadequate infrastructure and problems with the assimilation of new technology. Estimates of Soviet dependency on foreign equipment for several chemical products are provided.

In the first section, the new plan targets are delineated, the Chemicalization Program is discussed, and output trends for key products are presented. Second, the crucial area of factor utilization is analyzed, with plan targets examined in light of historic trends in capital-output ratios, degree of capacity utilization, and problems of assimilating new technology. In the third section, the industry's foreign trade performance is analyzed and the impact of the new plans on Soviet chemical exports is discussed. The fourth section concludes the paper and presents prospects for the Soviet chemical industry.

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I. Soviet Chemicalization Program and Output Trends

The Soviet chemical industry[1] was targeted as a growth sector and special contributor to the acceleration of scientific and technical progress during the 27th Party Congress as evidenced by the adoption of the "Comprehensive Program for the Chemicalization of the National Economy of the USSR for the period ending in the year 2000." [2] This is not the first Soviet chemicalization program (Khrushchev introduced the first in 1958), but it does mark a renewed interest in the chemical industry since the sharp curtailment of imports of foreign equipment in the late 1970's and the noticeable reduction in investment priority in the early 1980's. The recent concern with the chemical industry is due to disappointment with the "systemic lag" in its performance and the recognition that shortfalls in chemical production pose an acute problem not only for the chemical industry *per se*, but also for the modernization of the economy as a whole, because of forward linkages with heavy industry, especially machine-building and construction, and with agriculture. By the term "chemicalization" the Soviets mean increasing both the output of chemical products and their consumption by industrial branches and Soviet consumers. The three major tasks of the Chemicalization Program are to meet the requirements of the economy, to accelerate the development of the branch, and to improve the utilization of chemical products.

The primary goal of the Chemicalization Program is to increase output, which fell short by 2 billion rubles in 1985.[3] Output trends and targets are presented in Table 1. The other major programs of the 27th Party Congress require specific types of advanced chemical products; notably plastics manufactures for machine-building, highly refined products for microelectronics and optics, and multinutrient fertilizers and advanced pesticides for agriculture. The requirements of the national economy for chemicals as embodied in the 12th Five Year Plan (FYP) call for chemical and petrochemical output to increase to 130–132 percent of the 1985 level by 1990, while output in the year 2000 is to be 1.8–1.9 times the 1990 level. The implied average annual growth rate for the chemical industry during the 12th FYP is 5.4–5.7 percent, which exceeds the official average growth rate of 4.9 percent per annum achieved in the 11th FYP (1981–1985) and greatly exceeds the Western estimated average annual growth rate of 4.3 percent for this period.[4] The planned average annual growth rate for the period 1990–2000 is an ambitious 6.1–6.6 percent, remniscent of the early 1970's, an atypical period when chemical output soared due to the assimilation of new

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[1] The Soviet chemical industry includes basic chemicals, mineral chemicals, plastics, synthetic fibers, paints and dyes, pharmaceuticals, organic chemicals, tires and rubber-asbestos products. This designation corresponds to the term "the chemical and petrochemical industry" in Soviet handbooks.

[2] Kompleksnaya programma khimizatsii narodnogo khozyaystva SSSR na period do 2000 goda. Moscow: Politizdat, 1985.

[3] Pravda. June 19, 1986, pp. 1–5. Hereafter, Ryzhkov speech, June 18, 1986.

[4] Soviet official growth series are believed to overstate real output growth, and Western analysts have recalculated these series to correct for this problem. See USSR: Measures of Economic Growth and Development, 1950–80. Washington: U.S. Government Printing Office, 1982, for methodology. Official series data calculated from Narodnoye khozyaystvo SSSR v 1985 g., Moscow: Finansy i statistiki, 1986, p. 144 (hereafter, Narkhoz 19xx) and Western estimates from *Handbook of Economic Statistics, 1986*, Washington: U.S. Government Printing Office, 1986, p. 71 (hereafter, Handbook, 1986).

capacity from imported equipment. Additionally, the growth rate of key sectors is planned to exceed this average: plastics production, for example, is to increase by 36–42 percent (Table 1). Unlike the early 1970's though, growth in the 1980's and 1990's is to be based primarily on domestically produced equipment because excessive reliance on imported technology has been recently emphasized as a problem for the Soviet economy.[5]

TABLE 1.—OUTPUT TRENDS AND 12TH FYP GOALS FOR THE CHEMICAL INDUSTRY

(1,000 tons)

Year	Mineral fertilizers	Pesticides	Plastics and resins	Chemical fibers	Synthetic rubber
1960	3,281	32	312	211	380
1965	7,389	103	803	407	670
1970	13,099	164	1,670	623	1,030
1975	21,998	264	2,838	955	1,670
1980	24,767	285	3,637	1,176	2,050
1981	25,998	299	4,089	1,213	n.d.
1982	26,738	316	4,058	1,235	n.d.
1983	29,733	332	4,419	1,353	n.d.
1984	30,808	343	4,819	1,401	n.d.
1985	33,194	348	5,019	1,394	2,200
1990	41,000–43,000	440–480	6,800–7,100	1,850	2,700–2,900

Sources: *Narkhoz*, various years. 1990 12th FYP targets as reported in *Ekon. gazeta*, No. 12, March 1986, p. 10. Synthetic rubber series from Sagers and Shabad, 1986, Chapter 7.

Notes: Mineral fertilizers in 1000 tons of nutrient content, and pesticides in 1000 tons of active ingredients.

n.d. no data

The second task of the Chemicalization Program is the acceleration of the development of the chemical industry through increased capital formation and labor productivity, in order to achieve the ambitious output growth targets. One of the "most crucial" sections of the 12th FYP is the enormous capital construction program, totaling 994 billion rubles. Eighty percent of the total increase in investment is to be concentrated on the key programs; the Food, Energy, Machine-building, Electronics and Chemicalization Programs. Investment is the chemical industry alone is to increase by a factor of 1.5 during the 12th FYP. The chemical industry accounted for approximately 4 percent of industrial investment in 1950, but this share increased during the 1960's to about 9 percent in the 9th FYP (1966–1970) as chemicals became a higher priority under Khrushchev and Brezhnev. In the 1970's, investment in the chemical industry was about 9–10 percent of all industrial investment, but this share fell to 7.5 percent in the 11th FYP (1981–1985).[6]

Although the principal thrust of the Chemicalization Program is for increased output, the third goal is the more efficient utilization of chemical products througout the economy. First, chemical pro-

[5] For example, see Ekonomicheskaya gazeta, Number 11, March 1986, pp. 23–30, Ed A. Hewett, "Gorbachev's Economic Strategy: A Preliminary Assessment," Soviet Economy, Volume 1, Number 4, (October–December), 1985 and Ekonomicheskaya gazeta, No. 21, May 1986, p. 21. For Soviet accounts of the recent development of the chemical industry, see L.A. Kostandov *et al.*, Razvitiye khimicheskoy promyshlennosti v SSSR 1917–1980, Moscow: Khimiya, 1984, and V.V. Listov, Khimicheskaya promyshlennost' v odinnadtsatoy pyatiletke, Moscow: Khimiya, 1984.

[6] Data from Narkhoz, various years. Data for 1950 is based on 1962 prices, data for 1960 is in 1969 prices, and data for the rest of the years is in 1973 prices.

duction is to become less wasteful due to increases in recycling and improvements in the utilization of raw materials. Second, the effectiveness of using chemicals is to be raised by comprehensive application (using more than one chemcial product at a time), by the rational combination of chemical products with traditional materials, and by widening the consumption of chemicals in various branches of the economy. Increased consumption of plastics by the machine-building and metal working (MBMW) sector has been a nominal goal for the chemical industry for several years, but the extreme expectations for MBMW performance outlined at the 27th Party Congress mandate greatly increased deliveries of plastics and plastic parts to MBMW. In 1983, MBMW and construction accounted for 26.3 and 12.1 percent of plastics consumption respectively.[7] Utilization of chemicals is to improve not only in the "productive" sphere of the economy, but in domestic consumption as well. The Chemicalization Program includes the goal of raising consumption of consumer products which require chemical inputs, such as synthetic fibers, artifical leather, dyes, mordants, plastics, and paints and lacquers. The light and food industries consumed 13.7 percent of plastics output and 77.1 percent of chemical fiber output in 1983.[8]

II. Efficiency of Factor Utilization

The ability of the chemical industry to fulfill the ambitious targets described above (Table 1) depends on the allocation of factors to the chemical industry and the efficiency with which they are employed. The most important factor for any modern chemical industry is capital, since optimal chemical technology is highly capital-intensive. At first glance, traditional Soviet investment strategy would seem to be well-suited for meeting this requirement of the chemical industry; whatever the shortcomings of the traditional command economy system, one of its significant attributes is the ability to mobilize tremendous capital resources and to focus those resources on a few key sectors. For example, in the production of petrochemicals and the advanced chemical products which use petrochemical inputs (plastics, synthetic fibers, synthetic rubber), increasing the scale of the plant often leads to cost reductions and improvements in output quality.[9] As the data in Table 2 indicate, investment resources have been concentrated on the chemical industry.

[7] Listov, 1984, p. 14.
[8] Listov, 1984, p. 14 and 18.
[9] The Soviets have had some success with increasing the scale of chemical production, notably with "Polymer-60", a unit for low-density polyethylene, and with ammonia. The savings from increasing the scale of production are mentioned frequently in the literature; for a comparison see *Zhurnal vsesoyuznogo khimicheskogo obshchestva imeni D.M. Mendeleyeva*, No. 1, 1972, pp. 25-28, (hereafter, *Zh. Mendeleyeva*) and *Zh. Mendeleyeva*, No. 2, 1977, pp. 167-171.

TABLE 2.—INVESTMENT IN THE CHEMICAL INDUSTRY

Period	Million rubles—		Chemical industry share (percent)
	Chemical industry	Industry total	
1966–70	10,993	122,494	8.97
1971–75	15,616	172,500	9.05
1976–80	22,158	224,000	9.89
1981–85	22,600	300,700	7.52
Year:			
1981	3,800	49,500	7.68
1982	4,000	50,900	7.86
1983	4,100	53,700	7.64
1984	4,800	61,900	7.75
1985	4,500	65,500	6.87

Note.—Data from "Narkhoz," various issues. Due to a change in reporting this series, the years preceding 1984 are in constant 1973 prices while 1984, 1985 and the period 1981–1985 figures are in constant 1984 prices. A comparison of overlapping years shows a negligible effect of changing base upon the share estimates presented in the final column of the table.

TABLE 3.—IMPORTS OF CHEMICAL EQUIPMENT

Year	Chemical equipment imports (million FTR)	Percent share of chemical equipment imports out of—		Net chemical equipment imports (million FTR)
		All equipment imports	Total import bill	
1960	167.0	11.08	3.30	161.9
1965	187.4	7.73	2.58	182.6
1970	218.0	5.81	2.06	164.8
1975	638.0	7.05	2.39	558.6
1976	1,132.4	10.86	3.94	1,046.4
1977	1,722.3	15.02	5.72	1,618.0
1978	1,743.5	12.00	5.05	1,649.5
1979	1,753.6	12.18	4.63	1,656.4
1980	1,243.9	8.26	2.80	1,154.4
1981	825.5	5.47	1.57	739.8
1982	852.6	4.40	1.51	777.5
1983	1,042.5	4.58	1.75	955.1
1984	1,176.3	4.91	1.80	1,068.2
1985	1,042.5	4.06	1.51	944.0

Note.—Net chemical equipment imports are imports less exports. Chemical equipment imports and net imports are in million foreign trade rubles (FTR), and correspond to foreign trade nomenclature code 150, and thus exclude pumps and compressors (code 155).

Source: "Vneshnaya torgovlya SSSR," various years.

TABLE 4.—*Share of chemical output produced on machinery imported from the West: 1985*

Chemical product	*Share (percent)*
Nitrogenous fertilizers (all)	65
Ammonia	70
Urea	74
Multinutrient fertilizers	[1] 75
Synthetic fibers:	
"Nitron" (Orlon)	90
"Lavsan" (Dacron)	90
"Kapron" (Nylon 6)	[2] 75
Plastics:	
Polyethylene	94
Polypropylene	85–90

Chemical product	Share (percent)[1]
Polystyrene	60–65
Polyvinyl chloride	50
Cellulose acetate	[3]

[1] For 1980, see note 29.
[2] Not all imported equipment used in "kapron" production is from the West. Synthetic fibers are listed by their Soviet name, followed by their American equivalent in parentheses. For estimates of the share of primary petrochemicals produced on imported equipment, see Sagers, this volume.
[3] More than half.
Source: Sagers and Shabad, 1986, 12.

The increase in the chemical industry's investment share has been paralleled by an increase in the share of imported equipment. As the data in Table 3 indicate, the share of imported equipment allocated to the chemical industry has fluctuated over the period 1970–1985, reaching a peak of 15 percent in 1977. Access to imported technology was then cut back abruptly in the early 1980's, with the share falling to 4 percent in 1985.

The effect of this investment wave in foreign equipment is detailed in Table 4, which provides estimates of the share of Soviet chemical output produced by imported equipment for several important chemical products. As is evident, Soviet dependency on imported technology is extremely high for the advanced chemical products (synthetic fibers and plastics). It appears that investment resources channeled to the Soviet chemical industry since 1960 have been concentrated on foreign technology.

A. CAPITAL-OUTPUT RATIOS

In spite of significant investment expenditure, the USSR has experienced a number of difficulties in commissioning new capacity, assimilating new technology, upgrading existing facilities, expanding research and development (R&D), and meeting production plans in the chemical industry. These difficulties are reflected in rising capital-output ratios in the chemical industry.[10] The rising trend in capital-output ratios and the persistence of these problems in the chemical industy make the attainment of the ambitious FYP goals problematic. Capital-output ratios are presented in Table 5 in two variants; ratios calculated on the basis of official Soviet data, and ratios based on Western estimates. Official Soviet output series are known to seriously overstate real growth, due to methodological problems in their construction. Western estimates attempt to remove this bias, and show a rising trend for capital-output ratios over the entire period 1970-1985, with especially sharp increases in the mid-1970's and early 1980's. Even official Soviet data reflect a downturn in performance in the 1980's, although the problems in the 1970's are not reflected by the Soviet series. Apparently performance in the 1980's had so deteriorated that even inflation in the Soviet output series could not compensate, and so official capital output ratios declined.[11] The sharp increase in capital-output

[10] The Soviet economy as a whole is experiencing rising capital-output ratios, which is one facet of the overall growth slowdown that is examined elsewhere in this volume. This "negative trend in indicators" was severely criticized by Ryzhkov at the Party Congress while the chemical industry was singled out for a recitation of deficiencies and for increased investment, since it is a sector which effects overall economic progress (Ryzhkov speech, June 18, 1986).
[11] And additional reason may be the price change of 1982, which may have eliminated some of the new product bias in the output series. Using an official series based in 1984 prices with base year 1980 may reduce the scope for the new product bias and index number problems.

ratios in the mid 1970's is not surprising since several large plants, based on imported equipment, were under construction during that time. However, the increase in capital-output ratios in the 1980's was not due to new construction, but was caused by problems detailed below.

TABLE 5.—CAPITAL-OUTPUT RATIOS FOR THE CHEMICAL INDUSTRY

(1970 base year)

Year	Western series	Soviet series
1970	100.00	100.00
1971	102.28	103.93
1972	104.21	104.80
1973	103.21	102.38
1974	104.72	101.28
1975	105.00	100.47
1976	109.31	101.48
1977	112.53	103.49
1978	114.22	104.61
1979	125.09	110.46
1980	134.73	117.47
1981	142.25	121.21
1982	149.28	127.31
1983	151.28	129.60
1984	155.16	130.61
1985	156.04	133.54

Note.—Soviet series are based on data from "Narkhoz," various issues. Western series are based on data from "USSR: Measures," 1982 and Handbook, 1986 (see note 4).

Rising capital-output ratios can indicate problems in resource allocation, such as increasing only one factor of production, or accumulating capital without significant technical progress. Generally, rising capital-output ratios are a cause for concern.[12] Simple production theory indicates that even with constant returns to scale, increasing one factor leads to decreasing returns for that particular factor in the absence of commensurate increases in other factors, such as labor or raw materials. As detailed below, many Soviet chemical plants have experienced bottlenecks in input supply, and there is some indication that shortages of skilled labor are also becoming a problem. A resource allocation problem can also arise when the wrong kind of factor is used, for example if outdated or inferior equipment was installed. The reliance on foreign technology for the development of the Soviet chemical industry indicates that planners tried to avoid choosing outdated capital, but excessive lead-times sometimes rendered technology dated before full capacity was even achieved.

1. Degree of Capacity Utilization

The systemic influences which cause bottlenecks to be a persistent "dysfunction" in the Soviet economy are well known, and naturally the chemical industry has not been able to avoid them. The

[12] Some capital deepening can be expected as an industry matures, and thus a slight upward trend in capital-output ratios would not be surprising, although improved capital and labor productivity would offset such a trend. However, the steep increases in capital-output ratios in the mid-1970's and during the 1980's cannot be fully explained by capital deepening; rather they indicate the existence of significant problems, which are corroborated in the literature.

three major bottlenecks which plague the industry are input supply shortfalls, inadequate infrastructure, and power supply fluctuations. Due to the system of taut planning and the diffusion of authority across ministerial lines for new projects, some chemical plants have come on-stream with inadequate input supplies because supporting plants have not been commissioned. Input supply bottlenecks are a problem to a greater or lesser degree for all chemical plants, from small paint plants to large chemical combines, but are especially striking when they occur at high priority plants such as Tomsk, which failed to meet its production plans for polypropylene and methanol in 1982 and 1983.[13] The large increases in the production of plastics and fibers envisioned in the 12th FYP (Table 1) cannot be achieved without the necessary petrochemical intermediates, yet the prospects for increases in petrochemical production without new equipment imports are dubious at best.[14] Thus, a worsening of input supply bottlenecks during the 12th FYP for both the petrochemical and chemical industries is likely.

Overall, capacity in the chemical industry has been underutilized, partially due to interruptions in input supply. Some of the supply problems are due to the rapid expansion of the chemical industry in the 1970's; major claimants such as Tomsk were built without sufficient support. The "lack of planning" that results in such "disproportions" has been repeatedly excoriated by top Soviet officials, most recently at the 27th Party Congress, when complaints about the underutilization of capacity and the resultant reliance on chemical imports were aired.

Inadequate infrastructure, particularly a lack of rail transport and specialized storage facilities, is one of the major "disproportions" that has characterized the development of the Soviet chemical industry. This is a perennial problem with the distribution of fertilizers, and not even the creation of 1980 of a separate ministry solely for fertilizer production has alleviated the problem.[15]

Power supply fluctuations are the third serious bottleneck plaguing the Soviet chemical industry. Power supply fluctuations are particularly devastating for continuous process technology, because they cause significant losses of raw materials. Although chemical plants are supposed to be guaranteed a steady base-load power supply, in actuality fluctuations range from 5 to 30 percent.[16]

2. Problems of Assimilating New Technology

One of the benign causes for a temporary increase in capital-output ratios is the need for a certain amount of lead-time required to bring plants up to full capacity. However, cost overruns in construction and prolonged lead-times can extend this "temporary" problem for several years, which can no longer be described as benign. Additionally, if there are continued problems in assimila-

[13] The press is full of articles about input supply problems. For some examples, see *Izvestiya*, January 5, 1986, p. 2 (Tomsk), *Pravda*, November 1, 1982, p. 3 (Shevchenko), *Pravda*, March 16, 1983, p. 2 and March 23, 1983, p. 2 (Sokal'sk).

[14] See Sagers, this volume.

[15] For some examples, see *Pravda*, August 11, 1982, p. 2 and March 1, 1983, p. 1, *Izvestiya*, April 12, 1985, p. 3 and *Sotsialisticheskaya industriya*, May 23, 1982, p. 2.

[16] *Izvestiya*, May 18, 1982, p. 18.

tion, the plants may never reach rated capacity while capital repair costs mount.

The Soviet economy in general has been plagued with excessive cost overruns and long lead-times in bringing projects to full capacity production. The most obvious cause of long lead-times is the slow pace of Soviet construction, and measures to improve construction were discussed extensively at the 27th Party Congress. The problem has become so acute that Ryzhkov announced the scrapping of some projects with obsolete technology due to protracted construction delays. Such construction delays are probably the most significant problem facing the Soviet chemical industry today.

Protracted delays have always been a problem for the chemical industry, but this problem has worsened in the 1980's. In 1965 a survey found that construction norms were routinely exceeded by 50 to 75 percent, and it was estimated that completion of chemical plant construction was 2 to 5 years behind schedule during the 1970's.[17] In 1979, a survey of British chemical equipment exporters found that the "excess" lead-time in the USSR, aside from the negotiation phase, was two and a half to three years.[18] In the 1980's, chemical project lead-times were typically reported in the Soviet press at about six to seven years.[19] The volume of unfinished construction work in the chemical industry peaked at 9,188 million rubles in 1978, but has remained high in the 1980's, ending at 5,474 million rubles in 1984.[20]

The obsolescence of technology due to excessively long lead-times is a special problem for the chemical industry, since chemical technology changes very rapidly. Virtually every chemical plant constructed in the USSR since the early 1970's has experienced delays due to design changes. In several cases, projects have been close to completion, but technological advances have rendered them obsolete before start-up. The clearest examples of construction delays are the chemical complexes at Tomsk and Tobol'sk in Siberia. As originally planned in the early 1970's, these huge plants would take advantage of the petroleum and natural gas resources of Siberia and would be the largest plants in the USSR. However, these optimistic plans did not materialize; no synthetic rubber capacity was installed at Tobol'sk and designs were scaled back at Tomsk, although the plants remain among the largest in the Soviet Union.

The delays experienced at Tomsk and Tobol'sk are striking since the Siberian projects were so widely heralded, but the story is the same at nearly every chemical plant commissioned in the 1970's and 1980's.[21] These construction delays are the clearest signal that

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[17] Francis Rushing, "Soviet Chemical Industry: A Modern Growth Sector," in Soviet Economy in a New Perspective. Washington: U.S. Government Printing Office, 1976, p. 545.

[18] Philip Hanson and Malcolm R. Hill, "Soviet Assimilation of Western Technology: A Survey of UK Exporters' Experience," in Soviet Economy in a Time of Change, Volume 2. Washington: U.S. Government Printing Office, 1979, p. 594.

[19] Western estimates are usually much higher, depending on the definition of "lead-time." One source estimates that construction alone takes five to ten years, and this does not include the design or debugging phases. Ronald Amann and Julian Cooper, Industrial Innovation in the Soviet Union, New Haven: Yale University Press, 1982, p. 202.

[20] Narkhoz, various years. A new series was introduced in the 1985 handbook, based on capital investment instead of current construction costs. Using this data yields estimates of 5,616 million rubles in 1984 and 5,985 million rubles in 1985, but these estimates are in "comparable" (1984) prices.

[21] Matthew J. Sagers and Theodore Shabad, a forthcoming book on the Soviet chemical industry, 1986.

the USSR has had difficulty assimilating new technology, but there are other signs as well, notably the overall technical level of the chemical industry, the continued reliance on imported technology, and the relative performance of chemical plants installed in the USSR versus those in the West.

The technological level of the Soviet chemical industry was consistently below that of the chemical industries of the West from the 1940's to the 1970's,[22] and this pattern was predicted to persist because of severe problems with Soviet industrial research and development. A modern chemical industry is highly research-intensive, and its recent developmental pattern in the West has been that of a dynamic growth sector with a high rate of innovation and technological advance. Validating earlier predictions, Gorbachev identified shortcomings in Soviet chemical R&D as a major problem. Although Gorbachev cited specific examples of research institute inefficiencies, these comments were edited out.[23] Criticism of chemical machine-building R&D culminated in the abolishment of several research institutes, as announced by Ryzhkov on June 18, 1986, while chemical R&D is to be "reconstructed." [24]

Soviet chemical R&D shortcomings are reflected in continued dependence on imported technology. Unlike the Japanese, the Soviets have not been able to limit their purchase of licenses and equipment from innovating countries to a one-time creation of a starting base for domestic development of the chemical industry. Instead, the Soviets have had to keep on purchasing new equipment and licenses to make up for the lack of effective indigenous R&D.[25] Although the 1970's and 1980's saw some domestic developments, the dominant motif is continued reliance on imported technology, which is reflected in the shares of chemical production attributable to imported equipment presented in Table 4.

Out of the important modern subsectors, synthetic rubber production is the least dependent on imported technology.[26] But even the development of synthetic rubber production in the USSR has not been totally devoid of injections of imported equipment. During the 1970's, the Soviets imported single-stage butadiene units from Japan for petrochemical plants at Nizhnekamsk and Tobol'sk, a chloroprene assembly was installed at Yerevan in 1980, and several rubber processing assemblies for the production of tires were purchased.

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[22] See Ronald Amann and Julian Cooper, Industrial Innovation in the Soviet Union. New Haven: Yale University Press, 1982, pp. 127-211, and Ronald Amann, Julian Cooper, and R.W. Davies, The Technological Level of Soviet Industry. New Haven: Yale University Press, 1977, pp. 227-269. For a Soviet view, see G.M. Borisovich and M.G. Vasil'yev, Nauchno-tekhnicheskiy progress i ekonomika khimicheskoy promyshlennosti. Moscow: Khimiya, 1977.

[23] *Trud*, June 12, 1985 p. 1.

[24] *Izvestiya*, September 4, 1985, p. 2.

[25] For a comprehensive account of the recent development of the Soviet chemical industry see Matthew J. Sagers and Theodore Shabad, a forthcoming book on the Soviet chemical industry, 1986. Information on technology imports since 1970 was collected by the author from Soviet sources and the American journal Hydrocarbon Processing; an edited version of this data base is presented in Chapter 12 of Sagers and Shabad.

[26] The chemical industry can be divided into two groups: the older branches of mineral and basic chemistry which require simple technology and the modern or "progressive" subranches in which technical advance has been very important, namely synthetic rubber, plastics, synthetic fibers, petrochemicals, and special purpose products such as multinutrient fertilizers, herbicides, pharmaceuticals and highly refined substances for applied electronics.

Mineral fertilizer production is next in the ranking of import dependent subbranches. Soviet success in the production of simple mineral fertilizers is primarily due to its rich natural endowment of phosphate and potash and the relatively simple technology employed in the mining of these minerals. Although Soviet output of potash and phosphoric fertilizer is mostly independent from imported technology, the exact opposite is true for the important nitrogenous fertilizers and the advanced complex fertilizers which combine all three nutrients. Soviet production and exports of nitrogenous fertilizers expanded greatly during the 1970's and 1980's, due to the purchase of 29 ammonia plants and 10 urea plants, financed under compensation agreements.[27] These imported plants now account for 70 percent of Soviet ammonia production and 74 percent of urea.[28] In 1973, imported technology accounted for 74 percent of Soviet multinutritional fertilizer output, and scattered evidence indicates that this share probably has not declined.[29]

The other modern branches of the Soviet chemical industry are much more dependent on imported technology. The single most dependent subsector is synthetic fiber production, with most of the various types of fiber produced on imported equipment. Plastics production is also highly dependent on imported technology, and many of the plants that produce primary petrochemicals for plastics production have been imported. The USSR is a large net importer of paint and dye products and of pesticides and herbicides; subsectors which were slighted in terms of foreign equipment imports in favor of developing capacity in plastics, fertilizers and synthetic fibers.

Technology assimilation problems are reflected by the relative performance of imported equipment installed in the USSR. Although the Soviet press is full of anecdotes about the misuse of imported equipment, breakdowns and increasing capital repair costs in the chemical industry, it is hard to quantify this data. One survey of British chemical equipment exporters queried respondents on the performance of the equipment they had installed in the USSR, and there was some inferential evidence pointing to the Soviet inability to exceed the guaranteed level of output, although Western purchasers were expected to exceed this level routinely.[30] A different slant on this point is provided by capital productivity studies which indicated that at the margin, imported capital was more productive than domestic capital in the Soviet chemical industry.[31]

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[27] Soviet compensation agreements with the West are detailed in Jeanine D. Braithwaite, "Soviet Foreign Trade in Chemicals," Chapter 11 in a forthcoming book on the Soviet chemical industry by Matthew J. Sagers and Theodore Shabad, 1988.

[28] V. Klochek *et al.*, Soviet Foreign Trade: Today and Tomorrow. Moscow: Progress Publishers, 1985, p. 80.

[29] Share from Vneshnyaya torgovlya, No. 10, 1974, p. 45. In the mid-1970's, the USSR purchased five multinutrient assemblies from the West, with capacities from 1-1.4 million tons each. Soviet multinutrient fertilizer production in 1980 was not more than 7 million tons, so it is reasonable to assume that the share of output produced on imported equipment did not fall over the period.

[30] Hanson, 1979, p. 596.

[31] Donald W. Green and Herbert S. Levine, "Implications of Technology Transfers for the USSR" in NATO Colloquiem, *East-West Technological Cooperation*. Brussels: NATO, 1976. Donald W. Green and Herbert S. Levine, "Macroeconometric Evidence of the Value of Machinery Imports to the Soviet Union" in John R. Thomas and Ursula M. Kruse-Vaucienne (Eds.), *Soviet Science and Technology: Domestic and Foreign Perspectives*. Washington: George Washington University Press, 1977.

B. LABOR

Labor productivity goals traditionally receive considerable attention in the press, and the 12th FYP calls for labor productivity in the chemical industry industry to increase 29–31 percent, an ambitious goal. Although labor productivity in the chemical industry has grown faster than the industrial average, the increase from 1980 to 1985 only amounted to 23 percent. At the same time, it must be noted that labor itself is not all that significant a factor in chemical production. Most of the growth in chemical output and in labor productivity is due to capital inputs, not labor inputs, because chemical technology is so capital-intensive. For example, a 1977 study of labor productivity estimated that less than one-quarter of labor productivity growth was attributable to labor directly, through "improved labor organization", i.e. reducing personnel and increasing productivity.[32] The other three-quarters was due to capital-related factors such as improving "the technical level of production" (increasing the scale of production), changing "the volume and structure of production" (capacity assimilation, reducing bottlenecks, improving supply, and reducing equipment idle-time) and the introduction of new capacity.

The real significance of labor as a factor for chemical production is not in its aggregate productivity growth, but in the pattern of its allocation. The decision to shift the center of energy and chemical production to Siberia created some site-specific labor shortages due to the unattractiveness of that area to skilled workers and its inadequate social infrastructure. Inadequate infrastructure caused a site-specific labor shortage even in the mild climates of the Ukraine due to the absence of houses for workers.[33]

Although chemical technology is not especially labor-intensive, the chemical industry did foster the development of a labor-saving technique in the 1960's: the Shchekino method. In brief, the Shchekino method consisted of reducing the work force at a plant but not the wage fund and distributing the retained wages according to labor productivity. The Shchekino nitrogenous fertilizer plant which pioneered this method managed to increase output, labor productivity, and wages while releasing 23 percent of the work force from 1966 to 1980. However, the method did not diffuse throughout the economy—in 1982, only 6 percent of enterprises in the RSFSR had adopted the method. The reluctance of enterprises to adopt the Shchekino method was probably due to its undercutting by planning authorities. Even at the original plant, planners responded to reductions in the work force by decreasing the wage fund, eliminating incentive payments in 1975. The net effect of the Shchekino method amounted to the release of 968,000 workers during the 10th FYP, and there have been no recent reports about the method.[34]

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[32] Zh. Mendeleyeva, No. 2, 1977, p. 180.
[33] Izvestiya, December 6, 1981, p. 2.
[34] *Voprosy ekonomiki*, No. 2, 1983, pp. 58–68 and *Pravda*, June 14, 1982, p. 3.

III. Foreign Trade Performance

The Soviet leadership views the chemical industry as having "dynamic export potential" and the text of the Chemicalization Program includes a plank on foreign trade. Besides strengthening bilateral trade agreements with CMEA, the plank calls for the development of mutually beneficial economic ties with capitalist countries in chemical trade and improvement in the structure of trade turnover. The USSR is quite concerned with increasing the share of the "progressive" chemical products in export revenues, which translates into reducing the share of simple mineral fertilizers in chemical export revenues (around 40 percent). This section of the program calls for the creation of an "economic mechanism" to stimulate the production of high quality, competitive chemical exports.

This interest in chemical trade is hardly surprising since the Soviets have preferred to finance equipment imports by selling back part of the plant output to the equipment supplier through compensation deals. The importance of compensation agreements for the recent development of the Soviet chemical industry can hardly be overstated; in the 1970's nearly every plant purchased from the West was accompanied by a product buy-back deal.[35] Under existing agreements, the USSR is obligated to sell back 2,825,000 tons of ammonia, 1,191,000 tons of urea, and 380,000 tons of methanol every year. The Soviets have only recently begun to meet these contractual obligations; deliveries of ammonia and urea were to commence in 1978 while this level was only achieved in 1983 for urea and in 1984 for ammonia. Deliveries of methanol were to begin in 1981, but 1984 was the first year that this level was met. The reason for the delay in meeting the contracts was already explained in Section II, namely that the startup of most major chemical projects was delayed.

Compensation agreements seem to have been a phenomenon of the late 1970's since none have been reported with Western countries during the 1980's. This was partially due to Western reluctance to accept product pay-back in a relatively weak world chemical market.[36] Soviet enthusiasm for such agreements remained high, and it is likely that some petrochemical and chemical plants will be proposed for joint ventures with the West since most plant managers are already familiar with foreign equipment. Also, the new decree on foreign trade, which will allow some ministries and enterprises to trade directly with foreign firms,[37] may encompass some trade in chemical products.

The Soviet Union historically has been a large net importer of chemical products and equipment as can be seen in Tables 6 and 3. Not only is the USSR dependent on chemical product imports, but the structure of its trade pattern is skewed. Generally speaking, the Soviets import advanced chemical products and technology from the West and sell simple mineral fertilizers and basic chemical products in return. The increasing share of export revenues at-

[35] Braithwaite in Sagers and Shabad, 1988, Chapter 2.
[36] European Chemical News, July 22, 1977, pp. 4–12, and July 21, 1978, pp. 32–67, passim.
[37] Sotsialisticheskaya industriya, September 23, 1986, p. 1.

tributable to primary petrochemicals and ammonia has ameliorated this pattern somewhat, but interest in improving the pattern of trade remains keen since chemical exports earn hard currency. Additionally, the hard currency shortage currently affecting the USSR makes the reduction of chemical imports imperative since chemical products and technology purchases require scarce hard currency. In 1984, chemicals accounted for about 2.6 percent of hard currency export revenues and for 5.5 percent of hard currency import expenditure.[38]

TABLE 6.—TRADE IN CHEMICALS

(Million foreign trade rubles (FTR))

Year	Imports	Share (percent)	Exports	Share (percent)	Trade balance
1960	127.1	2.51	125.1	2.50	-2
1965	299.7	4.13	195.3	2.65	-104
1970	454.8	4.31	296.1	2.57	-159
1975	1,046.1	3.92	675.4	2.81	-371
1976	995.8	3.47	641.5	2.29	-354
1977	1,064.4	3.54	718.7	2.16	-346
1978	1,156.0	3.35	808.4	2.27	-348
1979	1,432.8	3.78	975.6	2.30	-457
1980	2,033.5	4.57	1,313.2	2.65	-720
1981	2,275.6	4.32	1,637.3	2.87	-638
1982	2,071.0	3.67	1,596.8	2.53	-474
1983	2,286.0	3.84	1,708.9	2.52	-577
1984	2,557.3	3.91	2,192.5	2.95	-365
1985	3,029.2	4.38	2,337.1	3.23	-692

Notes.—Chemical exports and imports exclude trade in natural and synthetic rubber since the series was discontinued in 1976. These calculated shares do not match those given in the front section of the trade handbook because of this exclusion and omitted data on explosives and pyrotechnics. Imports include data on synthetic and artificial fibers.

Trade balance is exports less imports.

Source: Vneshnyaya torgovlya SSSR (various years).

It is difficult to see where the 12th FYP goals leave much room for improving the unsatisfactory trade pattern. If plastics and fibers are to increase some 40 and 30 percent, then much of primary petrochemical production will have to go for domestic production, not exports. Conversely, if export levels are maintained, then consumption targets for MBMW, construction, and domestic consumers may require continued imports of plastics and fibers.

IV. Conclusions

The Soviet leadership has set out an ambitious plan for the development of the chemical industry through the year 2000, as indicated in the 12th FYP and the text of the Chemicalization Program. The quantative targets by themselves necessitate the introduction of new capacity, but the tenor of comments at the Party Congress seem to indicate that new capacity should be obtained from domestic production. However, it is quite clear that the Soviet chemical machine-building industry cannot provide the necessary equipment for plastics and synethtic fibers production. The chemical machine-building industry has little experience with the creation of the large plants needed in these sectors since virtually all of the plants installed in the 1970's were imported. Although some

[38] Calculated from Handbook, 1986, p. 72.

Soviet sources claim that the problem is solely in the structure and organization of chemical R&D, the fact is that the Soviets have hardly any experience in designing prototype chemical plants, let alone the massive units used in modern chemical production. Only a few of the developed Western countries have the expertise to design and build these advanced assemblies. Although the Soviets have realized gains by "reconstructing" old plants instead of building entirely new structures, it should be recognized that most of this reconstruction has required imported equipment. The savings result from decreasing the length of lead-time since the construction of entirely new buildings is not required.

Additionally, there are no real indications of a Soviet "learning curve" in chemical production. When the Soviets decided to expand ammonia production, they imported more ammonia plants from the U.S. When capacity expansion in plastics was called for, the Soviets purchased a series of plants from West Germany, France, Italy and Japan. With synthetic fibers, the Soviets imported not only the fiber plants themselves, but also the plants which produced the monomers for fiber production. Synthetic rubber is the only sector in which the Soviets have relied primarily on domestic machinery.

Some progress towards increasing production can be obtained if the Soviets manage to reduce input supply bottlenecks to fully utilize existing capacity. For example, polypropylene production at Tomsk was only about 28 percent of capacity in 1982 and another 72,000 tons could be obtained from eliminating this bottleneck. About 80,000 more tons of polystyrene could be obtained at Shevchenko if ethylene supply problems were solved. Another 80,000 or so tons per year of polyvinyl chloride might be obtained from Sayansk if the production process were debugged. An additional 250,000 ton polyvinyl chloride plant is currently under construction as well.[39] The assimilation of this excess and new capacity and incremental gains at other plants should increase Soviet plastics production by at least half a million tons over the next five year. However, the 12th FYP calls for increases of 1.8–2.1 million tons. Additional new capacity is clearly required if these goals are to be achieved.

Furthermore, the installation of new capacity in the production of final chemical products such as plastics and synthetic fibers necessitates the prior installation of extra capacity for the required monomers. Not only do the Soviets lack the ability to design and domestically manufacture the equipment for 1.5 million tons or so of extra plastics capacity, but it is unlikely that they will be able to increase monomer production as required, without significant equipment imports.[40] Even though new capacity in plastics production was added by the installation of imported equipment in the 1970's, Soviet requirements increased apace and plastics imports continued to constitute about 18 percent of all chemical product imports during the 1980's.[41]

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[39] Sagers and Shabad, 1988, Chapter 8.
[40] See Sagers, this volume.
[41] Braithwaite in Sagers and Shabad, 1988, Chapter 11.

The situation in synthetic fiber production is an even more extreme version of the assessment for plastics, since this sector is more dependent on imported equipment. Synthetic fiber imports comprise only a small share of Soviet chemical imports (between 3 and 6 percent in recent years) as they have been used primarily for the production of consumer goods. However, Soviet requirements for synthetic fibers will increase if the Chemicalization Program goals for heavy industrial use are met.[42] The 12th FYP calls for synthetic fiber output to increase by 33 percent, a target which probably exceeds the available excess capacity from supply bottlenecks.

The picture is somewhat more encouraging for mineral fertilizers and synthetic rubber, which have 12th FYP targets below the industry-wide average. Although simple mineral fertilizer output has steadily increased, the nutrient content of Soviet fertilizers lags significantly behind the West because of the low level of production of multinutrient fertilizers. The 12th FYP does not specify a target for multinutrient fertilizers, but rather indicates a growth rate of 24–30 percent for total fertilizer production. Soviet synthetic rubber production is relatively independent from Western technology, and production increased about 7 percent during 1980–1985. Of course, this is not the sort of performance mandated in the 12th FYP, which calls for an increase of some 23–32 percent.

The most unlikely planks of the Chemicalization Program are the proposed increase in the deliveries of chemical products to consumers and the improvement of the import side of the trade patterns. It is clear that the production of plastics and synthetic fibers will not meet projected industrial needs without major additions of new capacity, and it is hard to envision large increases in product deliveries for consumers when industrial targets are in doubt. It does seem likely that the USSR will continue to rely on chemical product imports, while the emphasis on the acceleration of scientific and technical progress will probably worsen the structure of imports as more revenues will be spent on the advanced chemical products produced in the West. As long as the USSR honors its compensation agreements, the export of primary petrochemicals should continue to improve the structure of chemical exports. However, if 12th FYP targets are deemed more important than increasing the share of "progressive" chemical products in exports, the share of export revenues attributable to simple chemical products may actually increase.

Overall, the Chemicalization Program amounts to a very taut plan for increasing Soviet chemical production. It is difficult to see how all these targets can be met, let alone in the absence of significant equipment imports. However, the chemical industry has been allocated a major increase in investment funds, and tenative signs about joint ventures and foreign trade must not be overlooked. Chemical equipment imports will increase if the Soviets are all all serious about their Chemicalization Program.

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[42] In 1983, only 19.5 percent of chemical fiber output was used in tire production and 1.6 percent in agriculture (for binding twine), while the light and food industries accounted for the rest of consumption. Listov, 1984, p. 14 and p. 18.

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COMMENTARY

By Philip Hanson*

Summary

The studies in this section show that Gorbachev's industrial modernization drive is being conducted in a rather old-fashioned Soviet manner. In particular, it is being managed "from above", and it is generating over-ambitious plan targets. In this commentary it is shown that policy towards the research and development sector, like industrial investment policy and output targeting, is rather traditional in approach. It does not, however, necessarily follow that Gorbachev's industrial modernization program is doomed to fail. It is important to allow for several factors on which our knowledge is only sketchy: the impact on productivity of the "new broom" effect of the personnel shake-out and the attempt to sharpen worker incentives; the influence of possible resource transfers (at the margin) from military production, and the contribution of imports—including imports from Eastern Europe. It is also important to remember that accelerated hidden inflation may create a statistical illusion of success in some key indicators. Some criteria are suggested for assessing the program's success in the next few years.

I. The Style of the Modernization Drive

In industrial economies, new products and processes are constantly being introduced and diffused in all lines of production. The activities which generate most of them, however, are concentrated: they center on engineering production and research and development (R and D). And much of the implementation of new technology requires investment. There is therefore nothing strange about the present Soviet leadership's decision to channel an increased proportion of resources into R and D, the engineering sector and investment. They are acting on the judgment that these growth-generating activities were neglected from the mid-1970s on.

Two aspects of Gorbachev's modernization drive, however, give rise to doubts: the large scale and abruptness of the priority shifts, and the reliance on pressure from above rather than on reforms which would strengthen incentives to raise productivity. In other words, priorities are being changed in directions which make good sense, but the change is being implemented in the old style, with a strong probability that many plan targets are too taut and that

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bottlenecks will be a serious problem. This is not to say that the modernization drive will do nothing to accelerate Soviet industrial growth; it may well do something. What it does not seem likely to do is to put Soviet industry on course to becoming competitive with the more dynamic Western economies. That, at any rate, is the impression given by the Twelfth Five-Year Plan (12 FYP). We have no useful information on policies for the 1990s; the handful of perspective-plan targets for the year 2000 seem to have been selected by a basketball coach, with height as the main criterion.

There are some signs of an "intensive" and "reform" approach which the Soviet planners have pointed to. Ryzhkov, in his speech at the Party Congress, said that in 1986–90 some key input-output ratios were to be reduced: for example, a 1.7 percent a year growth rate for steel rolling-mill production was to be obtained with almost no growth of coke and iron ore production, and that modest growth of steel output, in turn, was to support a growth rate of at least 7 percent a year in machine-building and metalworking (MBMW) output.[1] Talyzin, introducing the 1987 annual plan, claimed that the practice of planning each year from the achieved level was being abandoned in favor of adherence to the initial five-year plan—though only some of the 1987 targets seem to follow this rule.[2] The more efficient use of material inputs, however, is being sought through centrally-decreed targets, not through changes in the institutional framework; and the abandonment of planning from the achieved level has yet to be demonstrated in any instance where it hurts—that is, where the output of an industry or product-group has fallen short in year 1 of the level prescribed for year 1 in the five-year plan, but the annual-plan target for year 2 remains at the level set for year 2 in the five-year plan.

If the system is going to work, for the time being, in much the same way as it has in the past, analyses of the 12 FYP that are based on past performance must be taken seriously (though some qualifications to this are considered in part III of this paper). The papers by Leggett and Kushnirsky suggest that the 12 FYP will encounter bottlenecks at the level of national and sectoral totals. These difficulties ought to show up in independently-conducted studies of at least some particular branches and product-groups, and the other papers in this section do indeed tend, on the whole, to support the more aggregated studies. The same diagnosis, of an over-ambitious plan, is reached in several other Western studies;[3] indeed, as Kushnirsky points out, a number of Soviet economists have expressed the same view. The rest of this paper summarizes the evidence for bottleneck problems, adding some questions about the R and D sector in particular (section II); considers some influences which may nonetheless be helpful to plan fulfillment in reality (section III) and in appearance (section IV), and concludes (sec-

[1] *Pravda* March 4, 1988.
[2] *Pravda* November 18, 1986.
[3] Hanson, "The Soviet Twelfth Five-Year Plan," paper presented at the NATO Economics Colloquium, Brussels, April 1987; H.S. Levine and B. Roberts, "Soviet Economic Prospects and Their National Security Implications," paper presented at the NATO Workshop on National Security Issues after the 27th Party Congress of the USSR, Brussels, November 1986; J. Noren, "Soviet Investment Strategy under Gorbachev," paper presented at the AAASS meeting, New Orleans, November 1986; B. Rumer, "Realities of Gorbachev's Economic Program," *Problems of Communism*, May-June 1986, pp. 20–31.

tion V) with a review of indicators to watch in order to assess the progress of the industrial modernization drive.

II. Likely Bottlenecks

The modernization drive is at the core of an obviously ambitious medium-term plan. National income utilized is supposed to grow at 4.1 percent a year in 1976–80, against 3.2 percent a year in 1981–85. Yet labor inputs into material production are apparently expected to increase at only about 0.2 percent a year, against 0.4 percent a year in the previous five years; [4] and productive fixed capital stock is planned to grow 1 percent a year more slowly than in 1981–85 (5.4 against 6.4 percent a year). Even if sown area stabilizes (it had been falling slightly), it is obvious that any measure of total factor input growth will show a deceleration. Therefore plan fulfillment requires a remarkable improvement in the rate of productivity change. (With the 1982 factor-share weights used by the CIA for calculating total factor productivity change in GNP, total input growth would be planned to slow from 3.1 to 2.6 percent a year, and total factor productivity growth—in Soviet-definition national income utilized—would have to rise from 0.1 to 1.5 percent a year.)

The odds against such an acceleration must be high. The adverse effect on productivity of worsening natural-resource conditions is not expected to diminish. At the same time, the positive effect of inter-sector resource shifts, insofar as that effect depends on the movement of labor from the farm sector to industry, is more likely to diminish than increase. Sharp improvements in productivity growth are nonetheless being counted on. It appears that they would have to come from some combination of the following: improvements in average weather; the widening of key bottlenecks; further increases in the special earnings of foreign trade (which have contributed significantly to recent national income growth as officially measured); improved morale and effort, and faster technological change, in the sense of faster introduction and diffusion of new products and processes and of improved labor skills. Apparently a great deal is being expected from those of the possible benign influences over which the policymakers have some control.

It is therefore not surprising that analyses of the modernization drive arrive at skeptical conclusions. There are inconsistencies in it that are sufficient to cast doubt on the feasibility of the main targets.

A. Bottlenecks at National and Sectoral Levels

Noren's analysis of the 12 FYP investment program concluded that an implausibly high growth of total output was being projected. In the present volume, Kushnirsky's and Leggett's conclusions support this judgment. In addition, they both conclude that the planned growth of MBMW output (somewhat under half of which has in recent years been final machinery output for domestic in-

[4] Planned labor input growth derived from planned total labor productivity growth on the assumption that national income produced is set to grow 0.3 percent a year faster than national income utilised.

vestment) is unlikely to be enough to support the planned growth of equipment investment. Levine and Roberts reach the same conclusion, with the proviso that a drop in the growth rate of military hardware production might allow a sufficiently rapid growth of producers' durables output for domestic investment.[5]

Both Noren and Levine and Roberts—though using different methods of assessment—concluded that total energy supplies were not likely to be a constraint on planned output growth, but that supplies of non-fuel basic materials were likely to be a bottleneck. That conclusion is not undermined by the branch studies in this section.

Research and development can also be treated as a sector—albeit a sector made up of research and design organizations scattered across the various branch-ministries. An important aspect of the modernization drive is the increased priority given to this sector. Current expenditure on "science" is to rise by 5.9 percent a year in 1986–90, and capital spending by 11.2 percent a year.[6] Some increase in resource priority for R and D probably makes good sense. Greater attention to R and D hardware in particular—especially measuring and testing equipment, pilot plant facilities and the like—should help to correct an imbalance that has been much complained about. The dimensions of the shift, however, seem exaggerated.

Some acceleration of the growth and R and D staff numbers must be intended. Yet the absolute number of Soviet research scientists and engineers is generally considered to be excessive already, and research institutes have been extensively criticized in leadership speeches for being (in many cases) inflated in size and low in productivity. It is true that Western development in this sector has recently made more use of "extensive" growth than Soviet R and D has done. The growth in the numbers of Soviet research scientists and engineers, and in R and D expenditure, slowed considerably after 1975, while in the OECD countries the volume of research activity, after a slowdown in the early 1970s, was growing quite quickly. Nonetheless, if one can judge by results, Soviet R and D employment was either over-large to begin with or most of the best people were working for the military, or both.[7] The R and D sector seems to be a clear example of talk about "intensive" progress followed by policies of extensive growth.

B. BOTTLENECKS AT BRANCH LEVEL AND BELOW

The paper by Sagers and Shabad on petrochemicals, and by Braithwaite on the chemical industry, also illustrate the problems of an ambitious plan. They do so, however, at a level that is closer to operational decison-making about particular plants and products. The present structure of oil refinery capacity is such that plans for petrochemicals put a strain on the output of light fractions; changes in refinery capacity to produce more light fractions

[5] The reference is to the articles by Noren and by Roberts and Levine cited in footnote 3.
[6] Ryzhkov speech, Izvestiya June 19, 1986.
[7] For a comparative assessment of R and D productivity, see P. Hanson and K. Pavitt, The Comparative Economics of Research, Development and Innovation in East and West, forthcoming.

have been slow in coming, and the installation of the necessary equipment is likely to produce such changes, on any scale, only in the 1990s. Meanwhile the chemical engineering industry is still heavily committed, as Sagers and Shabad point out, to providing energy-sector equipment; and, as Leggett points out, the energy sector is set to continue taking a very large share of investment. Thus the question of where the necessary new equipment is coming from, is hard to answer. This is a sector in which reliance on imported technology has been exceptionally high, and the ability to design and develop many types of new chemical plants has not been built up.

An assessment of just how taut the plan is for the chemical sector, however, is still far from easy. Capacities to make a number of key products are substantially under-utilized—often because related "upstream" capacities are not completed. Correction of some of these intra-branch imbalances may be able to generate larger-than-expected output growth. There is also uncertainty about the possible role of trade, including trade with Eastern Europe (see section IIIC below). Nonetheless, the difficulties that are likely to arise in particular industries seem to reflect the strains and stresses of a generally over-taut plan.

III. Some Influences on the Outcome

Despite the analyses provided in this section of the compendium—and despite the general tenor of my own comments so far—it would be premature to write off Gorbachev's modernization drive. The outcome will be affected by many influences of which we have only a hazy understanding. Three such influences are worth a brief discussion here; all of them might be helpful to Gorbachev's program, and none of them has received the attention it merits.

A. THE NEW-BROOM EFFECT

In capitalist economies there is a social-interest case for corporate raiders. Competition in the product market is generally imperfect, and does not ensure that all companies must be close to maximum X-efficiency merely to survive. The corporate raider descends on companies that are using resources relatively poorly. He may or may not acquire a particular company, but either through acquisition or through a successful fight against acquisition the company rationalises its activities and ends up leaner and fitter. There is also a social-interest argument against corporate raiders: that the stock market allows very short-term considerations to predominate, so that a corporate raider can descend on a company that already is—in a longer-term perspective—lean and fit, and divert resources to the socially unproductive activity of fighting off bids.

Mikhail Gorbachev is a corporate raider who is doing his best to take over a particularly large company, USSR Inc; to carry out a management shakeout and a change of product-mix; and to launch the unwieldy conglomerate on a new and higher growth path. It is worth considering him in that light.

The Soviet case is surely one in which a corporate raider can do some good. Brezhnev's policy of stability of cadres allowed indolence and corruption to flourish among senior industrial officials. It

also must have made it easier for branch ministries to resist pressures from the central policymakers to accept more demanding tasks. At the time of writing, Gorbachev has replaced about 40 out of 90 heads of ministries and state committees. This should have had some effect in breaking up mutual protection circles, and making all office-holders inclined to try harder. Corrupt and incompetent officials have been replaced—if only by men who have not yet had their predecessors' opportunities. Some improvement in X-efficiency as a result is at least a plausible hypothesis. The anti-alcohol campaign may also contribute something to output growth in the medium term. We have no established way of assessing such effects, but some gains of this sort from the new-broom effect of a new leader may be forthcoming—as they seem to have been initially under both Khrushchev and Brezhnev.

B. TRANSFERS FROM THE MILITARY

There is some evidence that the allocation of investment within the engineering (MBMW) sector is being shifted from mainly-military to mainly-civilian branches.[8] Perhaps, too, a larger-than-usual share of the increment of MBMW final output will be producers' durables (the remainder would be military hardware and consumer durables). There is also evidence of increased efforts to transfer management know-how from military to civilian production.[9] The logic of this maneuver might extend to civilian and military shares in R and D. If it did, the argument put forward in section IIA, about extensive development of the R and D sector, would lose some of its force. In Soviet R and D with its present mix of activities, it is likely that more means worse, but a shift from military to civilian activities would probably raise the average quality of the latter.

The possible shift from "military" to "civilian" is not necessarily opposed by the military and military industry. It would be a shift, at the margin, from military production at current Soviet technological levels to the development of a cluster of electronics-based products with military as well as civilian applications in the long term. Therefore the military might well put their influence behind it. Needless to say, however, scenarios of this type are a matter of speculation on the part of Western analysts, with only limited evidence.

C. FOREIGN TRADE

One influence on the modernization drive will be what the Soviets can gain from imports of capital goods and advanced technology. Two assumptions are commonly made at present: that machinery imports from the West are unlikely to grow significantly in the late 1980s, and that it is only imports from the West which are important in this connection. In both respects, however, the prospects may not be quite as bleak for Moscow as they appear.

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[8] R.W. Campbell, "Resource Stringency and the Civilian-Military Resource Allocation," mimeo, October 1986.

[9] J.M. Cooper, "Technology Transfer between Military and Civilian Ministries," in this volume.

There is no doubt that Soviet hard-currency earnings prospects have been damaged by the 1981–86 slide in energy prices. It is also true that Gorbachev, Ryzhkov and Ligachev have all spoken emphatically about the dangers of dependence on imported Western technology. On the other hand, the plan targets themselves will generate pressure from the branch ministries for Western machinery; the competition between Western taxpayers to reduce other people's food bills has helped the Soviet balance of payments considerably and will probably continue to do so; and there may well be a reduction in the volume of Soviet farm imports. These considerations make some growth of machinery imports from the West more likely.

In addition, there is the possibility that we may underestimate the contribution that imports from Eastern Europe can make. It is true that East European machinery—particularly the machinery that the East Europeans make available to the Soviets—is not going to be technologically competitive, as a rule, with its Western counterparts. It is also true that East European capacity to provide more is limited by the lack of net investment in the smaller CMEA countries in recent years, and the Soviets' CMEA purchasing power will not be growing strongly. Nonetheless, it is worth bearing in mind that the East European contribution is not trivial. For example, Soviet imports of chemical equipment (ETN 150 in the foreign trade classification) from Eastern Europe in 1984–85 were on a similar scale to the imports from the West; each was contributing something on the order of one-third of total Soviet equipment investment in the chemical industry, and the imports from Eastern Europe were tending to rise faster than those from the West.[10]

IV. The Problem of Concealed Inflation

A final consideration relates to appearance, not reality. Gorbachev's industrial modernization drive sets particularly high targets for two activities: equipment investment and MBMW output. Both are officially reported in series that are known to be subject to concealed inflation: subject to concealed inflation, that is to say, to a degree which exceeds that of Soviet output in total. (The extent of the problem is better understood for MBMW output than it is for equipment investment.) Much of this concealed inflation comes about from the manipulation of "new product" pricing rules to the producers' advantage; phoney innovation has become a standard device for meeting ruble-value targets, not to mention targets for introducing new technology. Under the pressure of sharply increased targets for these activities, the pursuit of phoney innovation as a dodge for raising reported "performance" is in danger of becoming even more of a national sport than it already is. To put it another way: Gorbachev's new priorities are of a kind which the Soviet system is particularly good at pretending to meet. The new state quality control arrangements will work against this, but they may well not stand up to the strain.

[10] Derived from Vneshnyaya torgovlya SSSR v. 1985 and Narkhoz 85 p. 368, assuming that about 40 percent of chemical industry investment is equipment, and that Western machinery is priced domestically at its valued ruble price, as P. Bunich states in "Samofinansirovanie osnovnogo zvena," Voprosy ekonomiki 1986 no. 10, pp. 14–24.

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This is not a trivial point. Appearances often matter more than reality, and even the merest illusion of success will help Gorbachev politically.

V. Indicators for Future Assessment

Gorbachev's modernization drive relies too much on pressure from above and over-taut plans to be conducive to a genuine transformation of the Soviet industrial scene: that is the consensus view, and I think it is probably right. On the other hand, the new-broom effect, together with the correction of past errors, does provide grounds for anticipating some improvement in productivity growth. That is so, even though no breakthrough to general technological dynamism seems likely.

Any such improvement would show up in the growth of those industrial outputs which are reported in physical terms: not only basic materials and fuels but also bulk chemicals, cement, paper and the like, as well as some more highly fabricated products (e.g., plastics) which are reported in tonnage terms. The key areas of technical progress in machinery, however, and of investment volume, are not going to be reliably depicted in Soviet statistics. The best measure of progress in the technical sophistication of machinery and other manufactures will be Soviet export performance on competitive markets.

IV. DEFENSE INDUSTRY AND THE ECONOMY

OVERVIEW

By Richard F. Kaufman*

The papers in this section bring new light to the linkages between defense production and the Soviet economy, the burden of defense, and the problems of defense measurement. Establishing the connections between defense and the economy is no easy task. Even in the West where much more information about defense is known than in the Soviet Union, there are many questions about these interactions. The problem is exacerbated in the Soviet Union because of Soviet secrecy concerning defense. Nonetheless, there is much information about Soviet defense and economic performance from which reasonable inferences and conclusions can be drawn.

The lead-off paper by Abraham S. Becker probes "Gorbachev's Defense Economic Dilemma." Gorbachev came into power facing economic stagnation at home and a growing military threat abroad. On one hand, the United States was in the midst of a defense buildup while Soviet defense spending had been on a plateau. On the other hand, the heavy burden of military spending was already a drag on the Soviet economy. Increasing military spending to meet the perceived threat could compromise Gorbachev's domestic program.

Becker shows that Gorbachev's driving concern has been to revitalize and transform the Soviet economy. To achieve these ends, Gorbachev has advocated "radical" reform of "revolutionary" dimensions. Although it is not possible to know with certainty whether there will be a shift in resource allocations from defense to the civilian sector during the 12th Five Year Plan period (1986–1990), there are signs pointing in that direction.

A concrete indication of Gorbachev's commitment to economic over military development, Becker writes, is "the increasing conscription of defense industry to aid civilian production." He argues that without the extended cooperation of defense industry the planned modernization of the machine-building industries would be completely infeasible. The decision has been made to use defense industry expertise and experience in the production of civilian goods and in the technical re-equipping of the light and food industries, public services, and trade. Although this idea goes back many years and was emphasized by Brezhnev, Gorbachev may be carrying it on with greater determination. Indeed, Gorbachev's top prior-

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ity appears to be economic growth, followed by consumer welfare and then defense.

The military establishment seems to have made an accommodation with the Gorbachev program despite the implied constraints on the military budget. Becker argues that such acceptance would be based on the perceived Soviet lag in conventional military technologies and doubts in the minds of some military leaders about the ability of the USSR, burdened by a backward economy, to keep up with the accelerating pace of technological change. This is consistent with the U.S. intelligence community's view that the production capacity required to support Soviet military force modernization over the next several years is already in place.

The author goes on to say that the understanding between Gorbachev and the military might fall apart if there were significant military cutbacks to accommodate civilian needs, or if the growth of Western military power was not constrained. There might also be difficulties if there were slippages in Gorbachev's modernization program or an acceleration of Western technological progress.

Several of the important questions raised in Becker's assessment are discussed at greater length in the other papers in this section. Two contributions take up different aspects of the military burden question. Andrew W. Marshall comments broadly about the problem of measuring and understanding the full economic costs and future economic consequences of Soviet military and related programs.

Marshall believes that the existing measures of the military burden are not sufficiently comprehensive or accurate. The standard measure is the portion of GNP allocated for military activities. The difficulty is that the definition of what should be included in the military effort is too narrow in the Soviet context. He proposes a modified approach to estimating the military burden on the Soviet economy.

In Marshall's view, the Soviet military effort consists of three "tranches." The first consists of what are traditionally thought of as defense programs including men, research and development, and equipment. Second, are the resource flows to activities related to the first tranche, such as civil defense and industrial mobilization preparations. Third, is the cost of the "external empire" incurred in order to increase protection of the Soviet Union or expand its influence in the world.

Marshall's guess is that, if all these costs were totaled, they could comprise 20 to 30 percent of Soviet GNP over the past 10 years. This range is considerably higher than present official U.S. intelligence establishes which place the share of GNP allocated for defense at 15 to 17 percent. The higher figures, Marshall states, may help explain the decline in the growth rate of Soviet GNP. Further, the Soviet Union "may face requirements to invest in areas previously neglected, in part because of the large allocation of resources to the military." One example cited by Marshall is the health sector.

Murray Feshbach's paper, "Soviet Military Health Issues," can be read as a case study of the consequences of the kind of underinvestment in health referred to by Marshall. Ironically, part of the price the Soviet Union is paying for neglecting health care is

tiated then would be successful only as long as a very small number of ministries were involved, since their supplies could be provided by undersupplying other ministries. But, when more ministries got involved (according to the July 1985 resolution, by 1987), the effects would peter out, and the *status quo* would be restored.[40] At one of the discussions on the broadening of the experiment, a Soviet plant manager now raises the same question: "The problems of supply will undoubtedly be the cornerstone not only for the experiment, but for the entire 12th five-year plan. If they are positively solved for a limited number of firms participating in the experiment, it is necessary to think of what will happen if all firms switch to the new system." [41] The traditional Soviet system of priorities will answer the question. For instance, if additional inputs are channeled into the MBMW sector, what industries are to suffer most? Since lower supplies may jeopardize the renovation process, as well as other important programs, the authorities will minimize the possible slowdowns in the production of raw materials. Sherlock Holmes' deduction method then leaves us no choice but the consumer goods sector. It is always the consumer goods sector whose revival is sincerely promised but postponed, for new machines, or metals or oil are urgently needed.

Along with the costs, there must also be benefits from the modernization program. After all, every cloud has its silver lining. In the MBMW sector, investment will rise 1.8 times, and the growth rates will be 1.7 times those for the industry as a whole. Thus the MBMW sector will be a distinct beneficiary. Doubtless, the efficiency of some machines will increase, and, as a result, there will be improvements in the industries for which those machines are designated. But, as is typical in the Soviet case, advances will be limited to the specifically targeted branches or technologies. The experience of other, similar programs, such as electrification or chemicalization, is a good illustration. As a result of huge investments, electric power and chemical production advanced significantly, with some impact on the Soviet economy. Yet the projected effects of those programs—the elimination of manual jobs by the use of electrical machines and the massive substitution of metals and other natural raw materials by synthetics—did not materialize.

On the surface, there seems to be widespread support for Gorbachev's modernization program. Along with white collar workers in the military industrial complex, research and project institutes were enthusiastic about new and interesting projects, until the threat of liquidation has become real for some of them. The situation is also mixed in other industries. On the one hand, managers and engineers there support the idea of modernization. On the other hand, since the program will impose much heavier burdens on industries producing raw materials and, most importantly, the construction industry, the same managers and engineers feel unhappy about the prospects of being held responsible for failing to reach unrealistic goals. Mixed feelings also exist among economic bureaucrats, simplistically portrayed as sabotaging Gorbachev's ini-

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[40] Kushnirsky, F.I., The Limits of Soviet Economic Reform, *Problems of Communism*, Jul.-Aug., 1984:42-43.

[41] Chuprin, E.I., Comments in "Prava, ogranicheniia, perspektivy," *EKO* 11, 1985:64.

tiatives. Since technological modernization drains resources from other programs, in the past they knew that priority had to be given to the production targets. Presently, however, they must meet conflicting requirements for both accelerated economic growth and intensive modernization, and all of that with much lower supplies of material inputs. Finally, Soviet blue collar workers, unhappy about the antialcohol campaign, by and large remain indifferent to the modernization drive.

In sum, Gorbachev's modernization program is not consistent with a reform approach. It is highly contradictory: he wants to have entrepreneurship without entrepreneurs, thriftiness in production without personal financial liability, and high product quality without market competition. The program can, however, have potentially interesting consequences when Gorbachev becomes disappointed with its outcome. Two distinct possibilities will be open to him; he can declare every failure a success, as Brezhnev did since the mid-1970s, or he can look for alternative solutions. The available evidence suggests that he would prefer to avoid the first option. Yet, as time runs out and the number of commitments Gorbachev makes rises, it will become increasingly difficult for him to disassociate himself from the "mistakes of the past" and to change course. The fact that Gorbachev is aware of such a pitfall and is determined to keep all doors open explains the diversity and contradictions of his economic initiatives. Along with the modernization drive, notable are limited self-financing for industrial ministries and their greater autonomy is foreign trade operations, small-scale joint ventures, stiffer prosecution of "unearned income," legalization of certain private services and consumer goods manufacturing, and the enhancement of the economy's cooperative sector. At this point, however, it is not clear whether current experimentation is merely a patchwork or a beginning of a cautious revision of the Soviet economic model.

THE SOVIET CONSTRUCTION MATERIALS INDUSTRY: ITS ROLE IN ECONOMIC EXPANSION

By Christopher P. Pedersen*

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I. Summary

Mikhail Gorbachev's aggressive modernization program will challenge the construction materials industry to supply more and better quality products for renovating and expanding production facilities. In addition, his program to improve consumer welfare depends, in part, on more and better housing. Whether the industry can meet these challenges depends on its ability to overcome a number of problems that have contributed to its deterioration performance over the past decade.

Growth in the production of construction materials slowed abruptly between 1975 and 1982, when output rose on the average by only 1.1 percent annually. Factors contributing to slow production growth included the deteriorating quality and shortage of raw materials, aging plant and equipment, inadequate investment, shortages of labor, irregular supplies of energy, and transportation bottlenecks. These deficiencies were exacerbated by the fragmentation of administrative responsibility for the planning, production, and distribution of construction materials. Performance improved

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slightly during 1983–85, because of increases in industrial capacity and labor productivity. Growth, however, is still well below the rates necessary to assure an adequate supply of materials to meet investment plans for the balance of the decade.

Many of the factors that contributed to poor performance in 1976–82 are deeply rooted in the system. If Gorbachev's modernization program is to succeed, increased attention to the industry's problems is in order. The General Secretary obviously hopes that deemphasizing new plant construction and vigorous action to conserve construction materials will reduce the growth in demand for these products. He must, however, deal with two immediate problems: the inefficiency of construction materials production and the past inefficient allocation of investment to the industry. Gorbachev took a major step toward addressing the first problem by appointing Sergey F. Voyenushkin—a critic of current construction practices and an established innovator—as Minister of the Construction Materials Industry in July 1985.

Gorbachev will be hard pressed to reconcile his concomitant needs to boost investment in machine building, meet the investment needs of energy and agriculture, and increase investment in the construction materials industry. On the demand side, he will find it difficult to deemphasize new construction as such as he would like and to otherwise get the economywide construction materials conservation he is counting on. Therefore, unless investment is increased substantially to develop new sources of raw materials, commission new production capacity, renovate old plants, and increase output of processing equipment, continuing construction materials shortfalls will seriously hamper Gorbachev's modernization and consumer welfare efforts. Specifically, new housing starts will slow, capital renovation will be delayed, and the planned increases in the production of advanced and higher quality construction materials will not be realized.

II. The Setting

The efficiency of the national economy and the rates of our growth depend to a great extent on the structure and quality of materials. At present we are lagging in this task.—Mikhail S. Gorbachev, at the June 1985 Science, and Technology Conference.

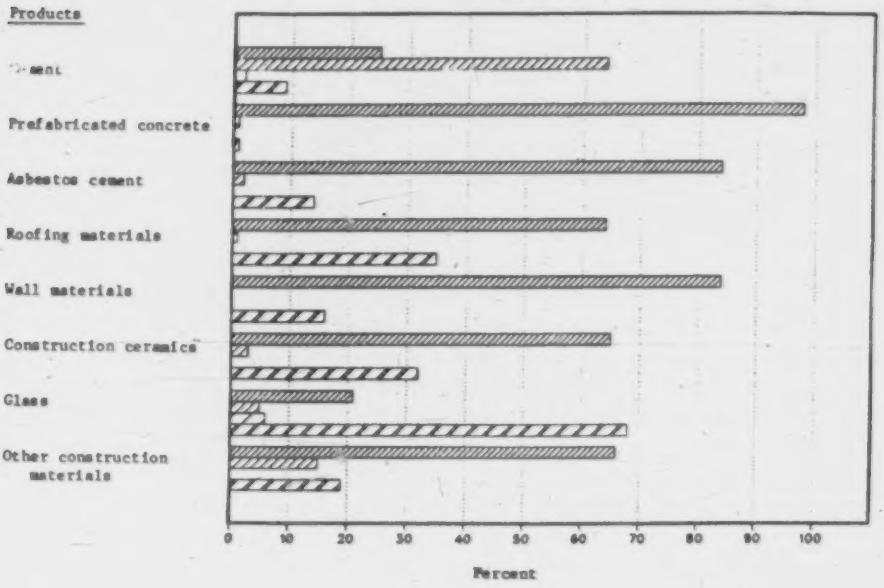
Since coming to power, Mikhail Gorbachev has set in motion the most aggressive economic agenda in the USSR since the mid-1960s. His initiatives are aimed at raising productivity and efficiency throughout the economy by matching more and better equipment with a motivated work force. Although Soviet economic performance has improved in recent years from the low levels of 1979–82, accelerated growth is required if targets are to be met.

One of the constraints to growth is inadequate investment for economic modernization and expansion. Renovating and reequipping existing enterprises rather than building new ones is a key element of Gorbachev's modernization strategy. Unless more resources are allotted to expansion of the construction materials industry, however, the goals for modernization and renovation of industrial facilities will not be achieved.

The General Secretary has stated that construction is the main support mechanism that will facilitate economic expansion. To maintain an effective construction sector, the construction materials industry must provide more and better quality materials, particularly cement, concrete, wall materials (especially gypsum), and ceramic products. About two-thirds of the total output of construction materials is used in domestic construction—both civilian and military. Construction is the largest consumer of cement, prefabricated concrete products, lumber, glass, bricks, and structural metal elements (see figure 1).

Figure 1

USSR: Estimated Disposition of Output From the Construction Materials Industry, 1982



Legend
- Domestic construction
- Construction materials industry
- Exports
- Other sectors of the economy

The various sectors of the construction materials industry are closely linked, with poor performance in one affecting the others. The key sector is cement, which "sells" over 60 percent of its product to six of the remaining sectors. Slow growth in cement supplies, for example, has constrained the production of prefabricated concrete, a major ingredient in construction.

THE SOVIET CONSTRUCTION MATERIALS INDUSTRY

The USSR Ministry of the Construction Materials Industry includes more than 300 production associations, enterprises, and organizations at the national level as well as 15 republic ministries. The all-union ministry is organized into seven general divisions—Administration, Industry, Economy, Science and Technology, Supply and Repair, Workers, and Miscellaneous—each of which contains several departments and administrations.

The Industry and Economy divisions are of primary importance because they coordinate planning and production targets with the State Planning Committee. Most of the other divisions provide contributions to the Economy Division when their efforts may affect plans and targets. The Economy Division measures performance and provides guidance when deviations from plans occur. The Industry Division is involved most heavily with the use of resources needed for material production and distribution. It contains the departments responsible for the eight product sectors of the industry—cement, prefabricated concrete, asbestos cement, wall materials, roofing materials, construction ceramics, glass, and other construction materials.

Although the industry processes many varied products that have uses in all sectors of the Soviet economy, output of the construction materials industry constitutes only 5 to 6 percent of total Soviet industrial production.

III. A Troubled Industry

Rapid increases in the output of construction materials in the 1961–75 period—up by an average of 5.5 percent per year—were followed by an abrupt slowdown in growth to only 1.5 percent annually in the last half of the Seventies. Since 1980, performance in the industry has been mixed: production virtually stagnated in 1981–82 but made a moderate recovery in 1983–84. The severe winter hampered output in the first quarter of 1985; by the end of the year, however, the industry had rebounded and posted growth of 1.5 percent for the year as a whole, a level similar to that recorded for 1984 (see tables 1 and 2). [1] Overall rates of growth in the output of construction materials, however, were less than half those originally targeted for 1981–85.

[1] Performance in the precast ferroconcrete sector was so abysmal that the Soviets withheld monthly production statistics for three consecutive months early in 1985.

TABLE 1.—USSR: AVERAGE ANNUAL GROWTH OF CONSTRUCTION MATERIALS OUTPUT

[In percent]

	1961–75	1976–80	1981	1982	1983	1984	1985
Total	5.6	1.4	1.5	−0.9	3.5	1.7	1.5
Cement	7.8	0.6	1.8	2.9	3.8	1.5	0.2
Prefabricated concrete	9.5	1.3	2.0	−0.9	3.8	3.2	−3.2
Wall materials	2.2	−1.6	0.4	−0.3	2.6	−0.5	−0.1
Asbestos cement	6.6	−1.4	2.0	1.5	4.1	2.8	2.2
Roofing materials	5.9	−0.4	−0.8	−0.4	7.9	2.4	2.3
Construction ceramics	6.1	2.5	8.7	5.8	4.9	2.5	2.7
Glass	5.2	2.0	−1.1	0.5	3.5	0.4	−0.7
Other construction materials [1]	4.9	3.8	1.5	−2.0	3.3	1.7	1.2

[1] Includes construction lime, gypsum, rock products, and mineral wool insulation.

Source: CIA's index of Soviet industrial production.

TABLE 2.—USSR: PRODUCTION OF MAJOR CONSTRUCTION MATERIALS

	1975	1980	1981	1982	1983	1984	1985
Cement (million tons)	122.1	125.0	127.2	123.7	128.2	129.9	131.0
Precast ferroconcrete (million m^3)	114.2	122.2	124.5	123.6	128.3	132.4	137.0
Prestressed reinforced concrete	27.2	27.2	28.1	27.6	28.5	29.4	29.6
Asbestos cement (billion tiles)	7.8	7.3	7.5	7.6	7.9	8.1	8.3
Wall materials (billion bricks)	63.0	58.0	58.3	58.1	59.6	59.2	59.1
Construction bricks	47.2	41.8	41.8	41.6	42.5	41.8	41.2
Refractory brick	33.7	27.5	27.4	27.1	27.6	27.1	26.6
Soft roofing materials (million m^2)	1.8	1.7	1.7	1.7	1.8	1.9	1.9
Roofing tile (million m^2)	1.9	0.6	0.6	0.6	0.7	0.7	0.6
Linoleum (million m^2)	71.9	93.1	95.1	96.2	99.9	106.0	113.0
Ceramic floor tiles (million m^2)	23.7	23.2	26.0	27.6	29.5	30.3	30.9
Styled ceramic wall tiles (million m^2)	24.1	32.6	35.4	37.5	39.3	40.4	41.8
Acid-proof ceramics (thousand tons)	601.0	609.0	605.0	601.0	616.0	612.0	606.0
Sanitary ceramics (million units)	8.9	9.6	9.7	9.7	9.9	10.0	10.0
Window glass (million m^2)	269.0	245.0	245.0	243.0	247.0	247.0	243.0

Source: Narodnoye khozyaystvo SSSR, various years (hereafter referred to as Narkhoz).

Most of the poor performance of the industry since the mid-1970s is due to the substantial decline in both the growth of capital and labor inputs and their productivity (see table 3). Many factors contributed to this decline.

TABLE 3.—USSR: AVERAGE ANNUAL GROWTH OF PRODUCTIVITY ON THE CONSTRUCTION MATERIALS INDUSTRY

[In percent]

	1961–65	1966–70	1971–75	1976–80	1981	1982	1983	1984	1985
Combined productivity [1]	−1.4	0.4	−0.2	−2.3	−1.0	−3.9	0.1	−0.7	−0.8
Capital	−7.5	−1.9	−4.1	−5.2	−3.4	−5.5	−2.4	−3.0	−3.3
Labor	4.9	2.7	3.7	0.5	1.4	−2.3	2.6	1.5	1.7

[1] Combined productivity is calculated using a Cobb-Douglas production function. Inputs of capital and labor are weighted with their respective income shares in 1982, estimated in the derivation of GNP at factor cost in that year. Labor is assigned 51 percent and capital 49 percent.

A. DETERIORATING QUALITY AND SHORTAGES OF RAW MATERIALS

The quality of quarry products, such as limestone and gypsum, has been deteriorating because of increasing reliance on the exploitation of marginal deposits. Soviet use of lower quality raw materials increases both production problems and costs. For example, according to one Soviet study, up to one-third of the decline in cement production in 1979 resulted from difficulties in processing low-quality raw materials.

Chemical additives—essential for building materials exposed to extreme cold—as well as steel reinforcing material and crushed stone are in short supply. Shortages of stone have caused concrete plants in some construction administrations to operate at as little as one-fifth of capacity in recent years. Although industrial byproducts, such as blast furnace slag, nonferrous wastes, and fly ash can compensate for inadequate supplies of some raw materials, annual increases in the availability of these substitutes have fallen off with the drop in growth rates of the metals and coal industries.

B. PROBLEMS WITH CAPITAL EQUIPMENT

The Soviets have added little new capacity in the construction materials industry since 1980 and, according to a plethora of Soviet press reports, much new equipment operates far below rated capacity. Moreover, the majority of the capital equipment currently in use is over 20 years old. The amount of repair work has consequently skyrocketed with shutdowns for repair—exacerbated by shortages of labor and materials—taking a significant toll on production and efficiency. Because of the limited additions to plant and equipment, Moscow—despite the growth of the pool of skilled repair workers—has been unable to compensate for this loss.

C. INADEQUATE INVESTMENT

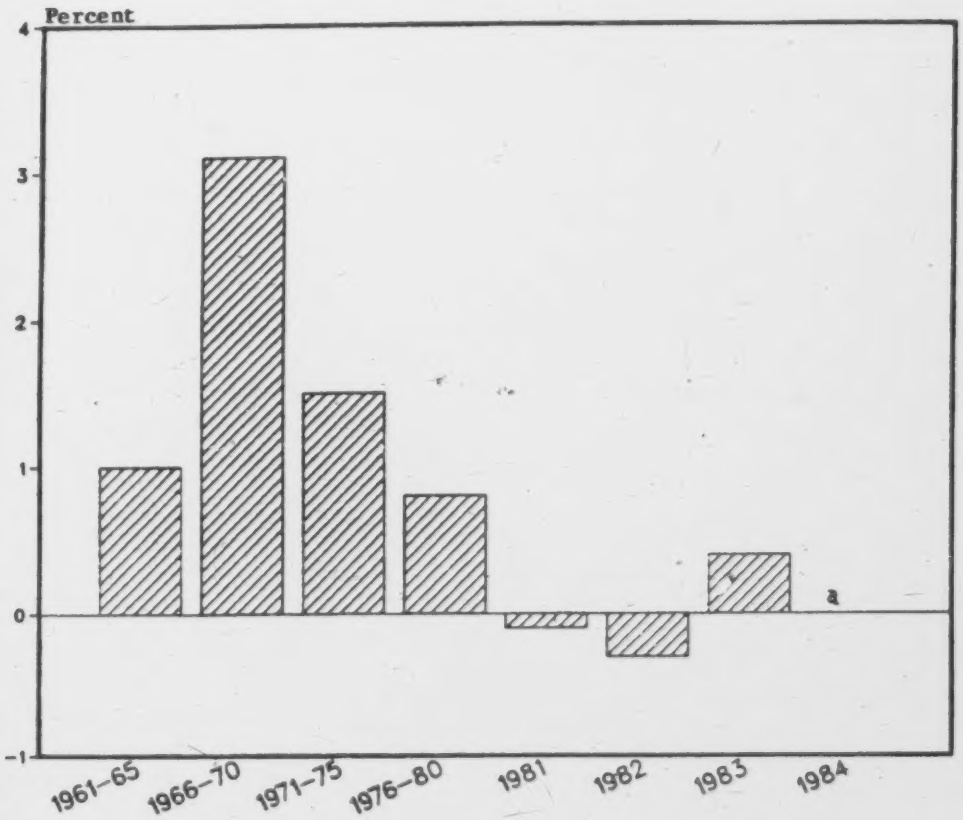
During 1971-75, the construction materials industry's share of total industrial investment was 5.5 percent. By 1985, its share had declined to 3.5 percent, reflecting the higher priority accorded to other branches of the economy. Moreover, the investment that has been dedicated to the construction materials industry, as in some other branches of industry, has been skewed toward the construction of finished product capacity to the relative neglect of developing raw materials, storage facilities, and social infrastructure such as worker housing.

D. SHORTAGES OF LABOR

In line with a general decline in the growth of the Soviet labor force, growth of employment in the construction materials industry has fallen since the early 1970s, with zero growth recorded in 1984 (see figure 2). This as resulted in an acute shortage of skilled labor across the entire industry. A large, continual turnover of labor because of inadequate investment in social infrastructure has exacerbated the problem. According to a Soviet industry expert, the share of such investment in the cement industry alone would have to be almost doubled to prevent excessive labor turnover.

Figure 2

USSR: Average Annual Growth of Employment in the Construction Materials Industry, 1961-84

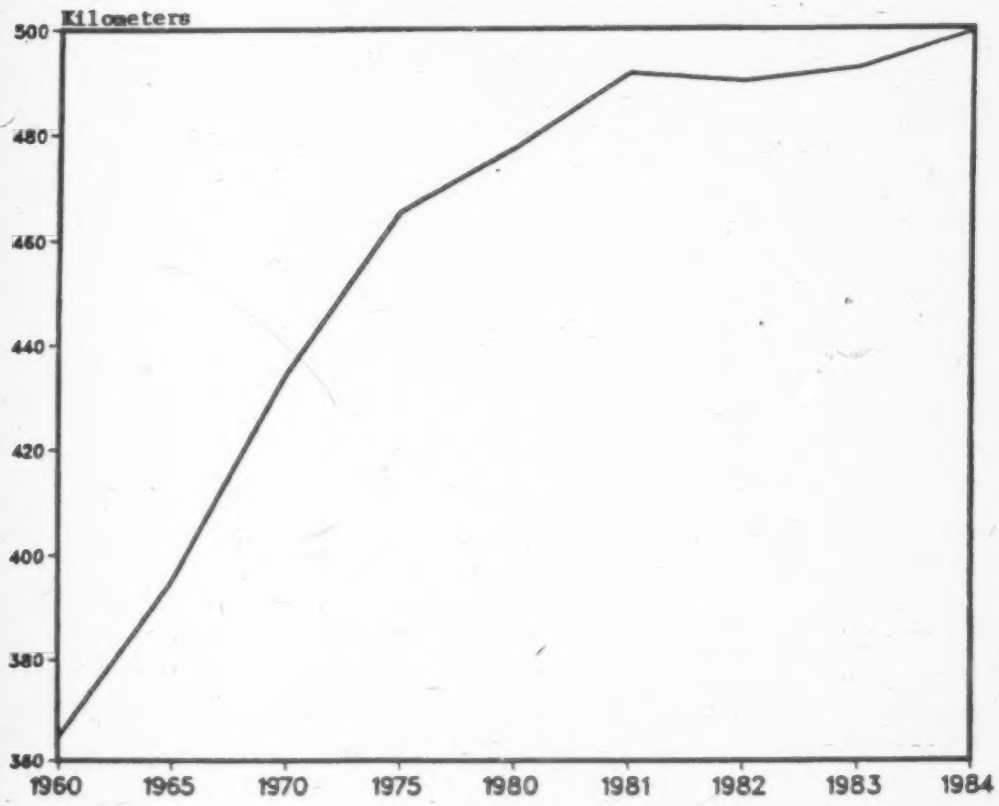


[a] Zero or no growth

Source: Narkhoz, various years.

Figure 3

USSR: Average Length of Haul by Rail for Construction Materials, 1960-84



Source: Narkhoz, various years.

E. IRREGULAR SUPPLIES OF FUEL AND ELECTRICITY

The construction materials industry is heavily dependent upon electricity and gas, and interruptions in the supply of energy have pushed down production of construction materials. Since the late 1960s, the industry has attempted to reduce its reliance on coal by replacing it with gas, which is both more efficient and reliable. Limited gas storage facilities and distribution lines, however, have prevented a faster transition.

F. TRANSPORTATION BOTTLENECKS

Bottlenecks in transportation—especially in 1979, 1982, and 1985—have also restricted output. The siting of many construction materials plants near raw material deposite has necessitated the transportation of building products over increasingly longer distances (see figure 3). As a result, Moscow has to cope with rising shipping losses due to theft and spillage along the route. Ironically, many of these same construction materials plants have exhausted the supply of raw materials at nearby quarries. As a result, heavy and bulky materials must be brought in from elsewhere, adding to the transportation system's already heavy burden.

G. FRAGMENTATION OF ADMINISTRATIVE RESPONSIBILITY

Administrative responsibility for the planning, production, and distribution of construction materials is divided among a myriad of organizations. The Ministry of the Construction Materials Industry is nominally tasked with these duties, but at least sixteen other ministries, committees, and directorates are identified with material-related responsibilities. For example, the Ministry of Ferrous Metallurgy produces the blast furnace slag to be used in slag bricks; the Ministry of Construction in the Northern and Western Regions produces concrete for civilian construction projects; the Main Directorate for Special Construction produces concrete for military construction projects; and the Ministry of the Chemical Industry produces and distributes polymeric materials and phosphogypsum. This division of responsibility exacerbates poor performance caused by the other factors noted above.

IV. Impact of Poor Performance

The poor performance of the construction materials industry, along with excessive waste in Soviet use of construction materials, has had a substantial negative impact throughout the economy. Many different industries as well as specific geographical areas have been affected. Although 1979 and 1982 were particularly bad years, shortages of construction materials have occurred consistently since the mid-1970s and have continued to affect Soviet enterprises in 1985 (see table 4).

TABLE 4.—USSR: SELECTED PRODUCTION SHUTDOWNS AND WORK STOPPAGES DUE TO CONSTRUCTION MATERIALS SHORTAGES, 1985

Date	Facility	Cause	Effect
January 1985	Nikol'skoye facility	Building brick shortage	Hampered construction for indeterminate period.
February 1985	Millerovo Metallurgical Equipment Plant.	Construction material shortage	Construction delayed for indeterminate period.
March 1985	Talasskiy Brick Plant	do	Plant reconstruction delayed; quarter plan 20 percent fulfilled.
April 1985	Karatav Chemical Plant	do	Construction delayed for indeterminate period.
June 1985	Chardzhou Chemical Plant	do	Half-year construction plan unfulfilled.
June 1985	Saratov Region	Roofing material shortage	Delayed rural construction.
July 1985	Baku Concrete Trust	Construction material shortage	Idled plant up to five days.
July 1985	Krasnoyarsk Heavy Excavator Plant.	do	Delayed construction plans by over one year.
August 1985	Latvia construction groups	do	Private construction delayed.
September 1985	Novolipetsk Metallurgical Combine.	Cement shortage	Paralyzed facility construction.
September 1985	Podolsk Experimental Cement Plant.	Construction material shortage	Slowed cement production.
September 1985	Tula Oblast'	do	Nine-month housing plan 73 percent fulfilled.

A variety of Soviet enterprises faced shortages of clinker and slag, glass, gypsum, refractory bricks, and slate during the year, resulting in construction being delayed, plants shutting down, and workers being laid off. Appeals to the State Committee for Material and Technical Supply (Gossnab) and the Central Committee of the CPSU have resulted only in the issuance of decrees calling for additional production from enterprises of the Ministry of the Construction Materials Induustry and increased availability of rail transport.

V. Past Attempts to Address the Problem

The Central Committee supports the ideas expressed at the June Science and Technology Conference on the need for . . . the production of efficient construction materials.—Mikhail S. Gorbachev, at Tyumen' in September 1985.

Senior Soviet officials have long been aware of the problems confronting the construction materials industry. As long ago as 1972, they recommended alleviating these problems largely by developing additional capacity, expanding automation, and instituting an economywide effort to conserve on the use of construction materials. However, these exhortations were not backed by sufficient investment throughout the Seventies. Since 1980, there has been little addition to the industry's capacity. Moreover, the limited success in automation has been unable to improve the quality of materials produced and reduce the labor intensiveness of the industry. The impact of these constraints has been magnified by Moscow's inability to move ahead smartly on eliminating waste in the use of construction materials and in reducing the material intensiveness of construction. As a result, Moscow has had to increasingly rely on imports to reduce the ensuing shortfalls.

A. NEW CAPACITY

To meet growing demand in the late 1960s and early 1970s, the Soviets expanded production of construction materials. By the late 1970s, however, this was no longer possible. Labor shortages hampered production, and investment allocations dwindled. The building of new construction materials enterprises was cut back so that, by 1981 and 1982, commissioning of new capacity was virtually nonexistent. Even though the industry was recognized by the leadership as important for economic expansion, it was not until late 1983 that this importance was translated into the commissioning of new capacity. In 1984, a considerable amount of new capacity was added, but new commissionings were still well below levels of the early 1970s (see table 5).

TABLE 5.—USSR: COMMISSIONING OF NEW CAPACITY IN THE CONSTRUCTION MATERIALS INDUSTRY [1]

[Million units]

	1966-70 [2]	1971-75 [2]	1976-80 [2]	1981	1982	1983	1984	1985
Cement (tons)	3.5	4.1	2.2	0	1.8	0.3	1.8	1.9
Asbestos cement shingles (tiles)	272.4	252.8	119.4	113.0	0	32.0	66.0	0
Precast ferroconcrete (tons)	4.8	5.9	5.1	5.0	4.3	5.3	5.0	3.2
Window glass (m^2)	5.5	6.9	5.0	0	0	0	2.3	8.0

[1] These figures include capacity originating in new construction and in expansion of existing plants.
[2] Annual averages.

Source: Narkhoz, various years.

B. AUTOMATION

With the decline in the growth of the labor pool and slow additions to new capacity, the Soviets began to look to automation as a means of expanding production through the substitution of machinery for labor. In addition, automation was seen as a way of assuring uniform product quality. Problems frequently arose, however, especially in the design of new plants. Enterprises were usually designed without detailed investigation of the specific types of equipment to be used or whether the equipment was to be fully automated, semiautomated, or not automated at all. As a result, additions to new capacity were often delayed.

To correct these problems, the All-Union Scientific Research and Planning-Design Institute for the Automation of Construction Materials Industry Enterprises developed three types of automated systems: the automated control system of production processes concerned with accounting, planning, and optimizing production resources, especially applicable in the area of inventory control; the automated control system for technological processes for automation of conveyor-type production lines (not robotics, but rather computer-assisted automated control systems); and the automated technological complex designed to control all plant production operations.

The introduction of this new technology, however, is being held back by the Soviet system's bureaucratic inefficiencies and lack of appropriate incentives. Plant managers, for example, are reluctant

to try any new production techniques since the time needed to install a new system, train workers in its operation, and then discover and correct defects substantially hinders the plant's ability to produce planned output. Management is also opposed to computerized inventory control, since it would reveal resource stockpiles used to ensure fulfillment of a subsequent plan, decrease the manager's "cheat margin," and lower the plant's chances to fulfill its production plan and the workers' chances to receive bonuses. Gorbachev may be hoping that some restructuring of the incentive system and performance indicators will overcome management's opposition to automation.

C. CONSERVING ON THE USE OF CONSTRUCTION MATERIALS

Moscow obviously hoped that a successful economywide conservation effort would reduce the growth in demand for construction materials and thus allow the industry to get by with reduced investment. Although lipservice was paid to conservation as early as the Ninth Five-Year Plan (1971-75), it was not until the 1981-85 Plan that the conservation drive picked up momentum. Between 1980 and 1984, the Soviets adopted several resolutions, held conferences, and implemented programs in an effort to conserve.

Two resolutions of the CPSU Central Committee in 1981 set forth both the problems necessitating conservation and ways to solve the problems. These resolutions were followed by an April 1982 All-Union Conference on the Conservation of Material Resources held in Moscow. This conference led directly to the November 1982 plenum of the CPSU Central Committee, which drew attention to the necessity for improving construction efficiency through measures for reducing the expenditure of fuel, raw materials, metal, and other products, as well as financial and labor resources.

In 1983, specific recommendations were adopted in a CPSU Central Committee resolution, which the construction materials industry coalesced into a three-pronged conservation strategy, including:

- —The preferential manufacture of products that facilitate a decrease in the weight of buildings and structures and an increase in their heat insulation.
- —The accelerated development and introduction of energy-saving technologies in the production of cement, ceramic products, glass, lime, and reinforced concrete.
- —The conservation of raw materials within the construction materials industry through a reduction in the material intensiveness of manufactured products and maximum utilization of secondary resources, including wastes of other sectors of the economy.

Although the Soviets have implementd numerous conservation programs, there are still relatively large losses of material resources. Resolutions, conferences, and decrees—the traditional cure-alls of the Soviet bureaucracy—have had relatively little impact. Given the shortage of building materials, construction crews cannot make up for the material supplies they have either failed to receive initially or wasted in the process of construction. Inefficient shipment and use of construction materials along with inadequate storage facilities which lead to spoilage have thus con-

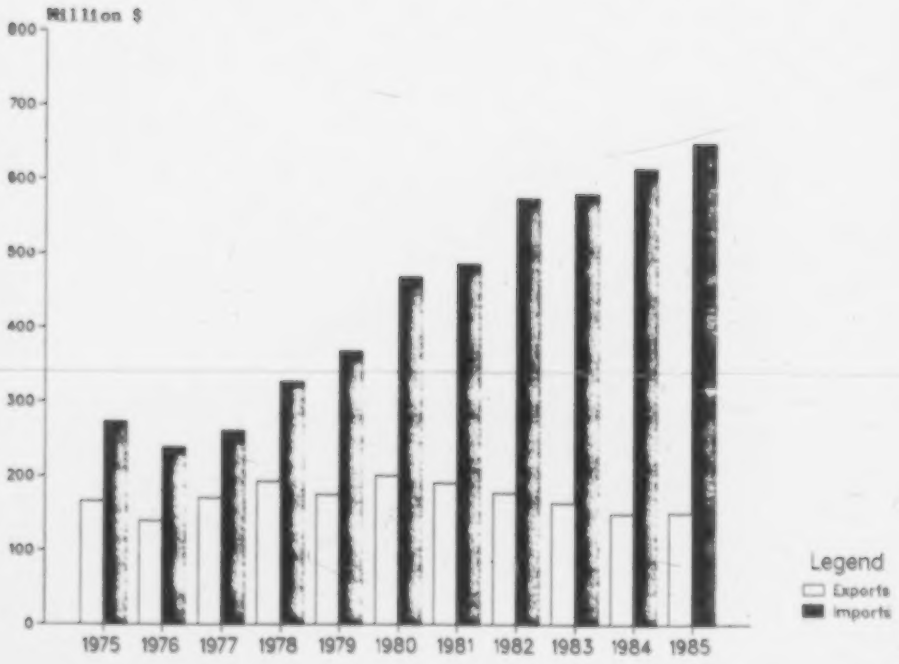
tributed to the high value of unfinished construction, which in 1984 amounted to 78 percent of annual investment for the Soviet economy as a whole, and 87 percent of investment for the construction materials industry. As a result of the continuing shortages, what little investment the industry received had to go toward increased capacity for basic rather than advanced, higher quality construction materials.

D. FOREIGN TRADE

With lagging domestic output, the Soviet Union has been forced to increase imports of construction materials, especially since the mid-1970s (see figure 4). Soviet construciton material imports are concentrated in the areas of insulation materials, linoleum, refractories, and wall materials. The value of insulation and wall material imports—$400 million in 1985—reflects the expansion of Soviet housing, especially in the Far East, far north, and the densely populated southern and southwestern portions of the country. The large value of refractory imports highlights continued problems in the cement sector and the steel industry. In 1985, imports of refractory materials totaled $114 million or three-fourths of Soviet domestic requirements.

Figure 4

USSR: Trade in Construction Materials, 1975-85



Source: Vneshnyaya torgovlya v SSSR, various years.

Since the mid-1970s, purchases from the Developed West have constituted approximately one-third of all construction material imports. A large share of imports—60 percent—comes from Eastern Europe and North Korea. In 1985–86, the Soviets were scheduled to import cement from Ethiopia, North Korea, and Poland and insulation materials from CEMA countries. The Soviet Union imports insulation materials from the United States, Italy, and Japan and buys refractory materials from France. The United Kingdom supplies a variety of materials. Overall, hard currency imports of construction materials totaled $175 million in 1985.

VI. Looking Ahead

The proportion of plastic materials, ceramics, and other advanced nonmetallic materials is still small in the overall volume of materials. We must exploit highly effective scientific and technological research developments, such as . . . highly effective types of polymer materials.—Mikhail S. Gorbachev, at the June 1985 Science and Technology Conference.

Although automation and conservation efforts have contributed somewhat to improved performance in recent years, the industry still has a long way to go. Gorbachev's emphasis on advanced materials in his economic agenda means that further action will have to be taken soon. Commissioning of new capacity during the 12th Five-Year Plan (1986–90) probably will remain relatively low given Gorbachev's emphasis on the machine-building sector and the substantial material savings in construction materials envisioned from renovating existing facilities. Although Gorbachev recognizes the need to reduce shortages of construction materials, he probably hopes that his emphasis on renovation as opposed to new plant construction, along with an intensive, economy-wide campaign to conserve on constuction materials use, will allow him to hold down the share of investment to the industry.

He has also addressed problems within the industry itself. In his 11 June 1985 address to the Conference on Science and Technology, Gorbachev chided the construction sector and the construction materials industry for the vast amount of unfinished construction. He emphasized the need to focus future work on plant modernization, a theme that has since been echoed in *Pravda* editorials. Whether he will be able to reduce demand is problematic. In any event, some new construction will be necessary to bring down the high level of unfinished construction in the industry and to add new facilities dedicated to the production of new, better quality construction materials that will be demanded by the construction sector, such as basalt plastics, glass ceramics, and polymeric materials.

Two major problems that thus require immediate attention are the inefficiency of construction materials production and the past insufficient allocation of investment to the industry. Gorbachev has taken a major step toward addressing the first problem; he selected a new Minister of the Construction Materials Industry, Sergey F. Voyenushkin, in July 1985. Voyenushkin was elevated from the post of RSFSR Minister of the Construction Materials Industry. The new minister has openly criticized the current system and has an established record of innovation. He is not in a position to address the fragmentation issue, however.

SERGEY FEDOROVICH VOYENUSHKIN

Age: 58

Member of the Communist Party since 1951

Graduate of the Karelian-Finnish State University

(Candidate of Economic Sciences)

Voyenushkin has been in the construction materials industry since 1958 and has held a variety of increasingly responsible posts:

1958-65—Deputy chief, then chief of the Administration of the Construction Materials Industry on the Karelian and Northwest National Economic Councils

1965-70—Deputy chief, then chief of the construction materials industry's Main Administration of the Nonmetallic Ores Industry

1970-75—Chief of the Planning and Economic Administration, USSR Ministry of the Construction Materials Industry

1975-79—First Deputy Minister of the RSFSR Ministry of the Construction Materials Industry

1979-85—Minister of the RSFSR Ministry of the Construction Materials Industry

1985-present—Minister of the Construction Materials Industry.

Voyenushkin has published numerous articles in the Soviet press and technical journals, many of which reveal his innovative tendencies:

—"Computed Net Production as an Index of Economic Activity of an Enterprise" (*Voprosy ekonomiki*, Dec 1976)

—"Construction in the RSFSR" (*Pravda*, 7 Jan 1978)

—"Effective Management of the Economy and its Aspects in the Construction Materials Industry" (*Pravda*, 16 Apr 1979)

—Discussion of the RSFSR State Plan and Budget for 1981 (*Leninskoye znamya*, 21 Nov 1980)

—"Subsidiary Enterprises Advanced; Developmental Problems Noted" (*Sovetskaya rossiya*, 4 Jun 1982)

—"Development of the Glass and Ceramic Industries" (*Steklo i keramika*, Jun 1982)

In his former position as RSFSR Minister of the Construction Materials Industry, Voyenushkin has demonstrated a willingness to deal with problems:

—He dismissed personnel in a construction plant for failure to meet construction deadlines and schedules in 1982.

—He dismissed personnel at another facility in connection with complaints of defective equipment in 1983.

—Under his leadership, the ministry exceeded plan targets for increased labor productivity and cost reductions in 1984.

A. SHORT-TERM INDICATORS

With the release of goals for the 1986-90 Five-Year Plan, we have some understanding of what the industry will be tasked with over the next five years, but little knowledge yet of the flow of investment to underwrite these tasks. Over the next year or so, indications that Moscow is moving aggressively to improve the performance of the construction materials industry would include:

—An increase in the investment allocated to the industry in the 1986-90 Five-Year Plan.

—Moves by Voyenushkin to replace ineffective managers throughout the industry as he did in the RSFSR.

—The widespread application of a system to ensure delivery of materials to construction sites in complete sets. This would alleviate excessive amounts of material supplies at construction sites, reduce losses of materials, and avoid work disruptions caused by inadequate supplies of specific materials.

—The formation of a new construction committee, encompassing the material-related responsibilities of the sixteen organizations currently having such responsibilities.
—The signing of major contracts with Western firms for the renovation of construction materials plants which could lead to modernization of a large portion of the industry and appear to be a high priority even with hard currency constraints.

B. LONG-TERM REQUIREMENTS

Areas that will require long-term attention include completion of unfinished construction within the construction materials industry and improvement of the system of reports and monitoring controls over the expenditure of material resources. Increased materials conservation and expanded automation will also be necessary.

Conservation in the general economy will make a long-term contribution by releasing scarce types of primary raw materials and supplies, increasing material resources, and reducing pollution of the environment by waste products. Specific measures probably will include the assignment of specific tasks for saving material resources both for the five-year plan and each individual year, the expansion of the production and introduction of lightweight structural elements and materials with high tensile strength, and the increased utilization of industrial waste products.

Accelerated automation is a key to continuing growth of the construction materials industry and could lead to a substantial increase in the efficiency of production: higher productivity of labor, greater and more uniform output, and reduced consumption of energy and raw materials. This will require a number of expensive measures over the long term, especially the mechanization and automation of basic and auxiliary production processes through the widespread introduction of computers.

C. PERSPECTIVES

Gorbachev will be hard-pressed to reconcile his needs to boost investment in machine building, meet the investment needs of energy and agriculture, and increase investment in the construction materials industry. He will also find it difficult to deemphasize new construction as much as he would like and get the economywide conservation he is counting on.

If investment in construction materials is not increased in the 12th Five-Year Plan period, additional new capacities will be slow to materialize, and the inefficiencies associated with an aged capital stock will continue. Sharply rising costs could exacerbate this problem. The construction materials industry will have few resources to use for mechanizing the numerous labor-intensive production processes that currently prevail. For example, according to press reports, about half of the workers in the cement sector are still employed in manual and auxiliary tasks. Planners, who hope to raise labor productivity through introduction of new high-efficiency machinery, increased mechanization and automation, and better social and cultural facilities at production enterprises, will find it increasingly difficult to modernize because all these im-

provements depend on higher rates of growth of capital investment.

The industry's efforts to improve its raw material supply position appreciably will also be affected by the performance of other industrial sectors. The plan to use more metal wastes and fly ash instead of rock products, for example, may be hampered by continued slow growth in the metals and coal industries and by transportation constraints. If fuel and power supplies cannot be made more reliable, production of construction materials will continue to falter.

In sum, unless investment in the industry is increased substantially to develop new sources of raw materials, commission new production capacity, renovate old plants, and increase output of processing equipment, continuing construction materials shortfalls will seriously hamper Gorbachev's modernization and consumer welfare efforts. Specifically, new housing starts will slow, capital renovation will be delayed, and the planned increases in the production of advanced and higher quality construction materials will not be realized.

METAL-SAVING AS A FUNDAMENTAL PRECONDITION OF INDUSTRIAL MODERNIZATION

By Boris Rumer and Yury Vatkin*

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Steel is the breed of our industry, our national resource. We must be especially frugal with it. It is necessary to be more active in applying progressive technological solutions.—Lev Zaykov, Central Committee Secretary for Industry, Politburo Member, August 1986.[1]

Summary

The modernization of the machine-building sector is one of the fundamental elements of the reindustrialization of the Soviet economy planned for the second half of the 1980s. The amount of investment in this sector of the economy is planned to increase by more than 80 percent over the level of the last five-year plan. Its output is to be raised by 40 percent. The share of output produced at the "world standard" is to reach 80–95 percent by 1990 from today's rather negligible levels.[2] In terms of its ambition, this grandiose plan can be compared only to the five-year plans of the era of Soviet industrialization. The first and second five-year plans failed because they were completely unrealistic. The current five-year plan can be compared to those plans when judged in terms of the mismatch between its ambition and prospects for success.

Introduction

Gorbachev announced in January 1987 that the problems facing the machine-building sector are being solved "with great difficulties." [3] His ecomomic advisor Abel Aganbegyan referred to the results of the first year of the plan period in the machine-building sector as "not encouraging." [4] This euphemism can be expressed in simpler terms as "very bad."

The difficulties mentioned by the General Secretary are associated with the shortcomings of the ecomomic system as a whole. They

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are discussed in other essays in this compendium. In the machine-building sector Gorbachev's program is faced with the following contradiction: the plan calls for a rapid construction of a modern building without creating a solid foundation capable of supporing this building.

One of the main components of this foundation is the question of steel supply. Ferrous metals constitute more than 95 percent of all materials used by the Soviet machine-building sector.[5] Under the conditions of shortage of steel resulting from the peculiarities of its distribution and consumption in the USSR, the fate of Gorbachev's machine-building program depends directly on the efficient use of steel. Prime-Minister Ryzhkov told the XXVII Party Congress that in the XII five-year plan period a 40–45 percent increase in the machine-building output must be accompanied by a mere 9 percent increase in the production of steel.[6] Ryzhkov stressed in his speech that growth in the machine-building sector should be achieved with the help of a more economical use of steel. Let us note that the shortage of steel has always been one of the main reasons for not fulfilling production plans cited by the Soviet machine-builders. The current five-year plan has placed an unprecedented emphasis on the effficient use of steel. Specific targets for steel economy have been included into the plan of every civilian machine-building ministry.* The statistical yearbook *Narodnoye Khozyaystvo SSSR* published for the first time in 1985 a special table dealing with "steel wastage in machine-building and metal-working." [7] Judging by the data reported in that table the share of steel wastage in total steel consumption is 22 percent and has remained constant for 25 years (since 1960). More than half of this wasted steel is a byproduct of metal-cutting.

Thus, in the XII five-year plan period the machine-building sector must plan to satisfy its demand for steel not so much by getting more metal but by using it more efficiently. For example, according to the current five-year plan, one of the main machine-building branches—heavy machine-building—must satisfy 75 percent of its new demand for steel by economizing. The use of steel in that branch of industry can be illustrated by the following statistics: in the production of locomotives 290 kilograms of every ton of steel is wastage; in the production of diesel engines 560 kilograms of every ton is wastage.[8]

Judging by published statistics, there has been an improvement in the use of steel in the machine-building sector. But even these statistics indicate that the improvement is nowhere near the plan targets.[9]

Extensive use of steel can be explained by many economic and technological factors. This paper is dealing with what we see as the fundamental obstacle standing in the way of efficient use of metal in Soviet machine-building—excessive use of casting and insufficient and technologically obsolete use of rolled metal. Here is what Premier Nikolay Ryzhkov has to say in this regard:

> In a number of branches of the machine-building industry a far higher proportion of components are produced by casting than is the case abroad, accounting for a total of 50–60 percent of the total weight of all machinery. [As a result,] from each

* We believe that this is also true for the defense machine-bulding sector.

ton of steel we produce far less finished product than is the case in the United States, Japan, and West Germany.[10]

Such patterns of steel consumption have led to proliferation of wasteful metal-cutting technologies and prevented a greated reliance on more economical press-forging processes.

This paper will address the problems of reduction of steel consumption in the machine-building sector. It will examine the state of casting and press-forging technologies in the Soviet Union. Greater use of rolled metal is a key component of the program intended to bring about efficient use of steel in the machine-building sector. It will be considered here as well.

Casting*

From the standpoint of the metal-output ratio, the extraordinarily high proportion of iron and steel casting is a characteristic feature of metal utilization in the Soviet machine-building industry. In the early-80s iron and steel casting constituted almost half of the metal used to produce machinery in the USSR or roughly 2–2.5 times more than in other industrialized countries.[11]

A survey of machine-building plants* conducted by the Central Statistical Administration in the early 1980s showed that 71 out of every 100 plants produced their own iron casting, 27—steel casting, and 84—forged pieces.[12]

Soviet specialists are well aware that the high proportion of casting hinders efforts to reduce the weight of machinery and is among the basic reasons for the high rates of consumption of metal in machine-building. But this sentence oversimplifies the situation and needs to be qualified. There are in the Soviet Union advanced techniques for the production of cast products which yield high-quality casting exhibiting a high degree of surface smoothness, with small machining allowances. However, a highly outdated mode of production of casting prevails; 80 to 90 percent of the overall output of casting is manufactured in sand molds.[13]

Because of poor tolerances achieved with castings and the need for laborious machining of the coarse, rough surfaces, in 1982 around 6 million tons of cast iron and 3 million tons of steel ended up as scrap.[14]

By smelting cast iron in induction furnaces—a technique widely used in many industrialized countries—it is possible to greatly reduce the weight and to almost double the strength of castings. But the Soviet machine-building industry uses cupolas instead. Most of them were built according to designs which are 30–50 years old. Induction furnaces have only just begun to appear at some Soviet machine-building plants. Very few plants in the early 1980's were equipped with these types of furnaces, and the volume of smelting performed was not great—roughly 3 percent to 5 percent of the total volume of output of iron casting.[15]

But the problem is not limited to the lack of induction furnaces. Modernization of casting shops cannot be accomplished by mere insertion of new furnaces in the existing environment. The whole structure needs to be completely overhauled. But this means a con-

*Most Soviet machine-building plants have their own casting shops.

siderable investment; furthermore, it would be necessary to temporarily stop or reduce the output of casting products which would constitute an extremely painful step. In general, obsolescence is a characteristic feature of Soviet casting technologies.[16]

The high degree of reliance of the casting process on manual labor hinders efforts aimed at achieving efficient use of metal in the foundry industry. Despite the feasibility of automation of the manufacture of foundry molds and cores,* manual labor still predominates. Machine-molding has the potential of reducing metal consumption in the production of castings, as well as the cost of the metal-cutting equipment. But in 1980 nearly one-fifth of all castings were produced using hand-manufactured foundry molds and cores.[17]

The shortage of foundry equipment is one of the reasons why considerable quantities of castings are manufactured by manual labor. A second reason can be found in the rather haphazard structure of the workpiece manufacturing process. It involves vast numbers of small-scale general-purpose shops where the introduction of any far-reaching changes in manufacturing technology encounters serious difficulties. In the early 1980s about 50% of all foundry shops and bays—of which there were over 5600 throughout the industry—produced less than 1,000 tons of iron castings annually (less than 3 tons a day).[18] Nearly half the shops manufacturing steel castings had annual output of less than 500 tons (less than 2 tons a day). Such volumes of output virtually preclude efficient utilization of the latest manufacturing techniques.[19]

Even in the 1960s it was already clear that further development of the Soviet machine-building industry is being held back by the poor state and inefficiency of this workpiece manufacturing base. The executives of Soviet industry saw a way of overcoming this problem in the creation of large-scale specialized enterprises that would satisfy the demand generated by different machine-building branches. The output of these enterprises would be uniform in terms of design, intended use, operational specifications for components and subassemblies. Today, within the foundry industry, there are several such large-scale specialized plants, with output of 50,000–240,000 tons annually, called foundry centers [tsentrolity].[20]

According to the original plans, the economic efficiency of these plants an the improved quality of their output should have resulted in a greater efficiency of the machine-building plants and elimination of many small scale primitive foundry shops.

But the new large-scale foundry centers have yet to play a significant role in increasing the efficiency of the foundry industry.[21] There are two basic reasons for this.

1. The foundry centers were been constructed at extraordinarily slow rates, and their construction involved costs far exceeding what had been planned initially, a factor which adversely affected the manufacturing cost of the output. Furthermore, by the time many of the plants were put into service, they had become technologically outdated.

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*These processes account for 40–50 percent of the total number of man-hours involved in the production of castings.

2. The very idea of large-scale foundries was based on the assumption that a large degree of uniformity and standardization existed in the Soviet machine-building industry which would require massive production runs and result in substantial economies of scale. But in reality the degree of uniformity and standardization in the machine-building industry is very low. It requires small production runs and results in frequent readjustments in the regime of the production process.

This has resulted in a mean lot size of castings of the same type of 15 to 20 tons. By contrast, at small plants the mean lot size is 50 to 100 tons. Once the foundry centers had turned to single-unit and small-lot production, they were unable to compete with foundry shops of machine-building enterprises whose manufacturing cost were lower. Under the conditions of small-run production application of new technologies is unsuitable and economically inefficient.

Departmental segregation in the machine-building and the complications encountered in the effort to fulfill the optimal order schedule of foundry centers have led to a situation where many machine-building enterprises prefer to produce the majority (well over 80 percent of components through their own efforts. This includes even uniform an standardized components.[22] For the machine-building industry as a whole specialized foundry works produced approximately 4 percent of all castings, whereas they could produce 50 to 55 percent.[23]

Modernization of the foundry industry as a whole would entails a redesign of the foundry shops, which in many cases constitutes an awesome task. This is especially true for the machine-tool industry. Only with considerable efforts does one find at these enterprises foundry shops which are not experiencing severe difficulties. In most cases, managers of machine-building enterprises point to the foundry shops as the weakest point in their production processes. In the Soviet machine-building industry reconstruction of any enterprise must begin at the foundry shop—such is the widespread belief held by workers and managers. There can be no progress in the machine-building industry unless the foundry industry is "put into order." Clearly, this will require substantial investments. Will the additional flow of investments in the machine-building industry as a whole included in the twelfth five-year plan reach the foundry shops?

Plans for the technical development of the foundry industry through the year 2000 call for the replacement of existing capacities that now produce 2,400,000 tons of castings by means of traditional, that is to say outdated methods, by capacities designed to produce precision castings. The plans also call for an increase in the percentage of foundry cast iron smelted in electric furnaces from the current figure of 7 percent to 47 percent, together with a corresponding reduction in the percentage of cast iron produced in cupolas. According to the calculations of Soviet experts, 7 billion rubles of capital investment will be required to implement this program; in addition, it will take 10–15 years to absorb these investments.[24] Given the existing investment conditions of the current five-year plan and, we believe, of the next or thirteenth five-year plan (1991–95) as well, the allocation and absorption of this investment for the purpose of modernizing the foundry industry appears

unlikely. A more realistic approach would involve a slow-paced technological improvement fueled by a smaller flow of investment.

At the same time, candid statements in the Soviet press leave little room for doubt that drastic improvements are necessary in foundry production. Otherwise, no real program of modernization of the machine-building industry as a whole, can succeed.

Metal-Forming

Metal forging using steam and air hammers and hot stamping is still the most widespread metal-forming technology in the Soviet Union. These processes are characterized by extremely low coefficients of utilization of metal; 0.33–0.38 in the case of components made from forged workpieces, and 0.44–0.52 in the case of components made by stamping.[25]

The overwhelming majority of stamping and forging is performed in shops and individual bays of integrated machine-building enterprises with full production cycles (i.e., enterprises where the production cycle began in workpiece shops and ended in assembly shops). Similarly to iron and steel casting, Soviet machine-building enterprises have attempted to meet their needs for forged and stamped products by using their own facilities. In the early 1980s roughly 65% of all shops involved in forging and stamping were small and inefficient works producing less than 3,000–5,000 tons of output annually.[26]

There are also individual large metal-forming shops at some machine-building enterprises that produce from 150,000 to 300,000 tons of stamped metal annually in large and mass-produced lots.[27] These shops have been built in the past 10–15 years, and can be found in a number of automobile and farm machinery factories. These enterprises are being technologically modernized at a rather fast pace.

But such enterprises are relatively few. Most machine-building factories have small metal-forming facilities and their rate of technological modernization is slow. There are a number of other causes, besides their small size, which are responsible for the slow pace of technological modernization of metal-forming production shops. These include the short lifetimes of stamping tools, as well as the fact that production of these tools consumes a considerable number of man-hours. There are many purely technological problems still to be overcome, particularly with the latest processes such as high-speed stamping, stamping of powder material, extrusion of tool steel under superplasticity conditions, and so on. And finally, substantial difficulties have to be overcome if the branch is to be supplied with the most modern metal-forming equipment, difficulties which we will now discuss in some detail.

At first glance, increasing the capacities and undertaking technological modernization of the existing metal-forming equipment does not appear to be a difficult task. The amount of this equipment in the Soviet Union is already quite impressive and comparable to the United States. Furthermore, the Soviet metal-forming equipment is not very old.[28] The amount of metal-forming equipment already in existence in the Soviet economy makes it possible to process more than 34,000,000 tons of rolled product, around 2,000,000 tons of

ingots, and around 800,000 tons of plastics annually.[29] There are also data which show that over the past decade Soviet industry obtained over 50,000 units of metal-forming equipment annually, and since 1980, over 57,000 units.[30] Considering these two sets of data together, it is clear that on the whole the scale of development of the industrial base in metal-forming technology in the USSR is quite impressive indeed.

A more detailed study of this issue, however, demonstrates that the inventory of metal-forming equipment differs from one branch of the machine-building industry to another in terms of its technical state and potential for meeting the needs of a particular subbranch. Hence, the differences in the scale and nature of the problems confronting the metal-forming production of the machine-building industry.

It would seem that a strategy of large-lot and mass production would be the easiest way for the Soviet machine-building industry to accelerate the development and modernizing of metal-forming equipment. But general-purpose, nearly unautomated (manually controlled) metal-forming machinery is still the basic and most convenient type of equipment.[31] It is for this reason that growing manpower shortages are experienced especially in the sphere of small-scale production.

How can this situation be explained? The answer is in the shortfalls in the production of contemporary metal-forming equipment. According to reports published by the Central Statistical Administration of the USSR, the total value of all metal-forming equipment produced in 1985 was 17.5 percent higher than in 1980.[32] But, according to the Ministry of the Machine-Tool industry, which is responsible for 85 percent of the total volume of metal-forming equipment, the plan was supposed to achieve 52.8 percent growth by 1985.[33] Thus, the production plan for metal-forming equipment had not been fulfilled and by a very large number.

The output of numerically controlled metal-forming equipment has more than doubled over the past five years, a fact which attests to high rates of growth in this area. However, we should bear in mind that production (in physical units) of programmed controlled metal-forming machine tools, which began only in the mid 1970s, has never exceeded 70–80 units annually. Clearly, the impact of this equipment on the Soviet machine-building industry is still barely noticable.[34]

The Soviet machine-building industry has accumulated considerable experience in the production of custom-made presses. However, the creation of systems of presses equipped with efficient (reliable) automatic manipulators presents an extremely serious challenge to the Soviet machine-building industry.

Experience has demonstrated that the process of development, design, assemble, and assimilation into the workplace of custom-made metal-forming machinery takes 4–5 years even under extremely favorable conditions. Thus, the assimilation of a number of novel custom-made machines now at different stages of development and manufacture should not be expected before the end of the current five-year plan.

Judging from the claims of Soviet planners, the development of the capacities for production of metal-forming equipment fall far

short of meeting the demand for it. At the end of the 1970s certain leading specialists of the USSR Gosplan believed that the cause for the suboptimal structure of metal-working technologies in the Soviet machine-building industry (with metal-forming machines constituting only a small fraction of the total inventory of metal-working equipment) was to be found in the inadequate level of development of the press-forging machine-building sector.[35]

Even quite recently (late 1985) essentially the same point of view was advanced by Genrikh Stroganov, deputy director of the USSR Gosplan in his discussion of the tentative production plan for the Ministry of the Machine-Tool Industry for 1986. In declaring that the production of metal-forming equipment was below the plan figures, Stroganov criticized the management of the ministry, holding them largely responsible for the slow progress toward greater use of plastic deformation and continuing reliance on metal-cutting processes.[36]

Thus, production plans for metal-forming equipment have fallen far short of targets for a long time now. This is the key obstacle standing in the way of the proliferation of efficient metal-working technologies in the Soviet machine-building industry.

Range and Quality of Rolled Product

Striking the right balance between metal-cutting and plastic deformation in metal-working constitutes essentially the same task as determining the proper ratio between the amount of cast and rolled metal in the production of steel. Efforts aimed at determining the optimal quantity of rolled and cast products in the overall volume of structural materials used in the Soviet machine-building industry must deal with a number of conflicting issues. The problem has not been solved, and may never be solved as long as the range of rolled product remains entirely inadequate.

The State Planning Commission and machine-building ministries have tried to make a convincing case for doing away with cast product and replacing it with rolled product, more precisely, welded parts made from flat-rolled metal. This would help save metal by reducing the amount of scrap from machining and through the use of lighter welded parts. But Soviet steel plants are not able to supply the machine-building industry with rolled product of the proper dimensions and shape and, consequently, a considerable proportion of the metal is turned into chips in the course of machining, or scrap in gas-cutting operations.

Because of the limited range of products, no great reduction in the weight of machine parts can be achieved. As a result, the volume of metal waste in the manufacture of machine parts from rolled product is not simply not lower than when casting is used, but in fact is much higher. In the production of energy-converting machinery, metal waste in the case of rolled product is 31 percent higher, in the automobile industry 16 percent higher, and in tractor and farm machinery cosntruction 44 percent higher.[37]

The limited range of rolled product manufactured in general and an insufficient output of rolled product with enhanced strength properties in particular has led to the widespread practice of re-

placing unavailable shapes and dimensions of rolled product of a desired quality with larger sizes of sheet of reduced quality.

The result has been an increase in the weight of structures and machinery without any basis in the stress analyses nor the technological demands, and also to extraordinary volumes of waste in the machining process. Here is the reason for the low utilization factors for steel in the chemical machine-building industry (0.7), the automobile industry (0.68), and machine tool manufacture (0.6).[38]

A far lower proportion of the total volume of rolled products manufactured by the Soviet steel industry consists of flat-rolled metal, by comparison with the situation in other industrially developed countries (40–42 percent versus 60–65 percent).[39]

The use of thermally hardened and low-alloy steel sheet and roll-formed shapes is also a major factor in reducing the structural metal-output ratio of machinery. In the early 1980s, low-alloy steel sheet amounted to 13 percent of the total volume of flat-rolled product, thermally hardened rolled metal around 6 percent, and roll-formed shapes a little more than 1 percent. This is quite insufficient to meet the needs of the Soviet machine-building industry.

From the theoretical standpoint, it might be asserted that rolled product ought to supplant casting where there are no constraints on the range of products. But it is highly unlikely that these constraints will disappear in the foreseeable future. In absolute terms, therefore, the production of steel and iron casting will unavoidably increase. The Soviet machine-building industry now had no other way of producing structural metal and billets.

The chief goal in the diversification of product assortment in rolled steel production was to increase the share of sheet metal in the total production of finished rolled steel.

In the late 1960s, a scientific group within the State Committee for Science and Technology concluded that the proportion of rolled product in the form of sheet must be increased to at least 45 percent by 1975 and to 50–55 percent by 1980.[40] But the share of flat rolled steel was 38 percent in 1970, 40 percent in 1975, 41 percent in 1980, and 41 percent in 1985. But by 1985 the plan called for this proportion to increase to 45 percent. If that goal were achieved, then the production of finished rolled steel in 1985 (109 million tons) would produce a sheet steel output of 50 millions tons; but in fact only about 45 million tons are produced.

Each year the Soviet Union plans for steel mills to introduce about 100 new varieties of rolled product.[41] These plans, however, have not been implemented and remain a dead letter.

While there are many obstacles to plans for producing new types of rolled metal, the primary one is the fact that steel plants have no interest in burdening their capacities with the production of ranges that are not economically beneficial to the enterprise. It should be emphasized that, under these circumstances, this means inevitable conflicts with the consumer machine-building plants, for whom the limited product mix in rolled metal means a higher metal input, higher production costs, and in a number of cases, the general impossiblity of constructing the required machinery.

It is, furthermore, worth noting that Soviet standards for rolled steel assortments do not correspond to the contemporary demands of modern machine-building. These standards, in a very substantial

degree, are inferior to analogous standards in the industrially developed countries of the West. Thus the Soviet standards include a smaller number of alleviated, thin-walled and especially complex forms of rolled metal.

Conclusion

The consumption of steel per unit of national income is twice as high in the Soviet Union as it is in Western industrialized countries. This situation is supposed to be corrected by the year 2000. At the same time the volume of steel output is projected to remain at the 1985 level.[42] This is dictated by the program approved by the XXVII Party Congress.

An acute and growing shortage of steel constitutes a characteristic feature of the current situation in the Soviet economy. *Sotsialisticheskaya Industria*—a newspaper of the Central Committee—wrote in late 1986 that without immediate "extraordinary measures the deficit of steel can become truly enormous. Many scholars consider the [current] situation with steel critical." [43]

According to the *Main Directions of the Development of the Soviet Economy by the Year 2000*, the solution to this problem is in the economical use of metal, increase in production of flat rolled steel, its qualitative improvements and greater variety.[44] However, contrary to the plans of the Soviet leadership, there has been no increase in the demand for rolled steel and even a decrease in its consumption by such key industries as machine-tooling and electrical machine-building. Moreover, even more telling is a forecast prepared by the machine-building ministries. They predict that, contrary to the *Main Directions* . . ., the share of rolled steel in the consumption by such industries as automobile and energy machine-building will not increase by the year 2000 and in some industries, such as machine-tooling and chemical machine-building, it will fail.[45] Gosplan's leading expert Ivan Pashko believes that in the first half of the 1980s the supply of flat rolled steel in the Soviet Union exceeded the demand for it from the machine-building sector because enterprises were not ready to use rolled metal instead of casting.[46] The ministries demonstrate their eagerness to save metal through the use of high-quality rolled product and transmit requests for the production of this type of steel to the steel plants. However, the machine-building enterprises are not ready to use it and avoid receiving it.

Due to the low inadequate technological adaptability of the machine-building industry to the pressing, stamping and welding of flat-rolled steel, there is great demand for steel and iron casting. By contrast, the demand for rolled sheet steel is relatively low. The Soviet machine-building industry is switching to high-quality rolled metal very slowly and, therefore, steel plants have little incentive to expand output of rolled product.[47] It is impossible to establish how the responsibility for inefficient use of metal should be divided between steel-makers and machine-builders. One should not expect to see the proliferation of metal-saving technologies in metal-working under these conditions.

The ministries can show great improvements in metal-saving in their reports by manipulating consumption rates. But these num-

bers have little credibility. Macro-level statistics on metal consumption reported in yearbooks and newspapers are no more reliable. According to the statistical report for 1986 "the consumption of metal per unit of national income* fell by 0.6 percent."[48] But there is reasonably solid evidence that national income indicators are not deflated.[49] As a result, the reported per unit of national income consumption of metal is lower than the real number. If adjusted for inflation, these statistics may yet reflect a further increase in metal consumption.

Based on the analysis presented in this paper, there are few reasons to predict that in the foreseeable future technological factors will provide a substantial contribution to a more efficient use of metal in the Soviet machine-building sector. Real progress in this sphere can be achieved if economic factors are brought into play and changes are made in the existing economic mechanism. But this depends on the fate of Gorbachev's promised economic reform.

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MODERNIZATION OF THE SOVIET STEEL INDUSTRY: WHAT LIES AHEAD?

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I. Summary

Modernizing the Soviet steel industry is crucial to the success of Gorbachev's industrial modernization effort. Without major improvements in the quality and variety of steel products, the General Secretary's program to develop and produce modern technologically sophisticated machinery and equipment will be seriously hampered. Accordingly, Moscow has adopted a wideranging program for reequipping the Soviet steel industry and expanding the mix of output, specifically by:

—Reconstructing older steel plants.

—Replacing open-hearth steelmaking furnances with basic oxygen or electric furnances.

—More than doubling the share of steel continuously cast by 1990.

The steel modernization program focuses on elements that could lead to improvement in product quality and variety. Gorbachev has a strong incentive to push for progress in this important industry, but the cost of effectively carrying out the program during 1986–90 may outstrip the resources available for it. Domestic machine builders will be unable to meet the demand for more reliable and sophisticated metallurgical machinery. In addition, a program based on reconstruction and technical reequipment poses particular difficulties for the Soviet steel industry.

Turning abroad for help, Moscow will find little near-term relief. Acquisition of modern Western equipment—especially turnkey projects which can be put into operation more quickly than domes-

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tically supplied facilities—will be limited by reduced hard currency earnings, probably for the rest of this decade. Nor can the Soviets depend heavily on their East European client states for much additional machinery. These countries already supply Moscow with a large share of their machinery production and are ill prepared, and probably unwilling, to meet heavy new demands for more and better machinery exports.

On balance, some progress will be made in modernizing the steel industry. For example, greater use of modern furnaces and continuous casting will improve the efficiency of the steelmaking process during the late 1980s and help the Soviets meet their goals of increasing rolled steel output without increasing production of some inputs. Completion of some of the new and renovation projects planned during 1986–90 could help meet demands for higher quality products in key sectors of the economy.

Despite these improvements, however, the Soviet steel industry will face too many obstacles to fully meet the demands of the economy, at least for the remainder of the decade. As a result, we can expect to see:

—Continuing complaints from various ministries (especially the machine-building ministries) about inadequate variety and quality of steel products which, in turn, will inhibit progress in modernizing the machine-building sector—the centerpiece of Gorbachev's industrial modernization program.

—Machines that continue to outweigh their Western counterparts, perform fewer functions, and need to be repaired or replaced more often—thus siphoning scarce resources away from modernization and into capital repairs.

—Continued need for imports of many Western steel products, such as plate and sheet for the machine-building branches and pipe for the oil and gas industries, adding to the strain on dwindling hard currency resources.

The failure to make major improvements in the steel industry over the next few years will increase the risk that Gorbachev's ambitious modernization goals for the remainder of the decade will not be met. As the Soviet leader is able to assess how modernization is faring, he may be in a position to better plan improvements that could be implemented in the 1990s. However, prolonged delays and setbacks to current modernization plans will also increase pressure on the regime to either back off its ambitious program or make more fundamental changes in the system that might provide both the incentives and the resource slack necessary for meaningful improvements to occur.

II. The Importance of Steel to Gorbachev's Modernization Program

After all, even today the lag of the metallurgical industry is affecting other sectors. If we do not ensure a drastic improvement in the quality of metallurgical industry output, if the range of goods it produces does not meet present-day and future requirements, then we will be unable to achieve the necessary breakthrough in machine building and also . . . other spheres of the national economy.—Pravda editorial, 13 November 1986.

General Secretary Gorbachev's industrial modernization program requires the ferrous metals industry to sharply improve the quality and expand the variety of steel products provided to key sectors of the economy, particularly the machine-building and energy industries. Specifically, Gorbachev's program has raised the demand for hundreds of new and better steel products—from drill pipe for the oil and gas industries, to high-performance electrical sheet for transformers, to special alloy steels for lighter, stronger, precision machine tools.

The machine-building industry is the largest consumer of steel, and meeting its demand for steel products will be crucial to achieving Gorbachev's modernization goals. The increased rate of growth planned for machine-building output in 1986–90, coupled with Moscow's call for improving the quality of domestic equipment and conserving metal, requires steelmakers to both raise the quantity of finished output and produce a larger share of new high-quality steel products and products with special properties.

Sharply growing demand for more and better quality steel products in the oil and gas industries will add to the burden on the ferrous metals industry in the coming years. The oil ministry is planning to substantially accelerate the pace of development drilling and the number of oil well completions during the 12th Five-Year Plan (1986–90). The demand for drilling rigs, drill pipe, casing, and tubing will grow accordingly. In addition, plans to develop the deep sour oil and gas condensate fields of the Pre-Caspian Depression will impose stringent requirements on the steels used in the fabrication of production and processing equipment that can withstand extremely high pressures and temperatures as well as resist the corrosive environment found in these deposits.

Finally, the defense sector will continue to demand more and better steel products as weapon systems now in the field are replaced with new ones whose performance characteristics require closer tolerances, lighter weight, and greater strength. Some weapon systems, especially armored vehicles, have traditionally consumed enormous quantities of steel. Output of weapon systems requiring specialty steels—such as advance fighter aircraft and new types of munitions which contain specialty steel materials—will require the Soviet steel industry to produce larger quantities of advance, higher quality steels.

III. A Troubled Industry

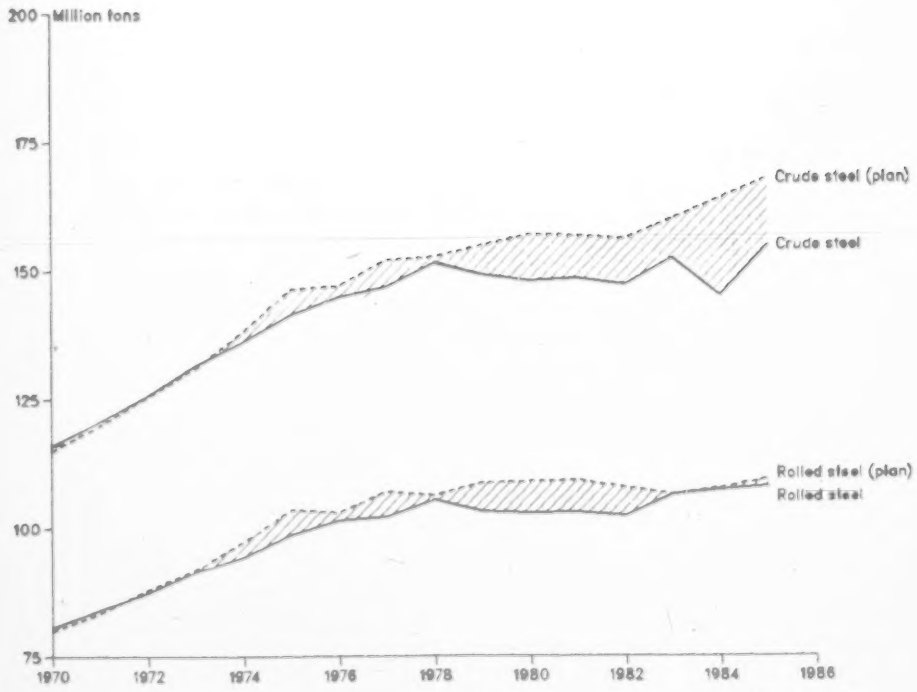
The steel industry is ill-prepared to meet the challenge of Gorbachev's call for more and better products, because of both outmoded production facilities and perverse incentives which define success (and bonus allocations) more on the basis of tonnage than on type or quality of finished product. Indeed, the overall record of the steel industry during the past 10 years has been one of traditional failure to meet expectations, despite substantial imports of Western equipment and technology (see figure 1). Previous regimes have called for steel mills to introduce hundreds of new varieties of high-quality rolled products, but the preponderance of poor quality, out-of-date domestic metallurgical machinery has fostered low quality, narrow assortment, and shortages of steel products. As one

leader in Soviet machine building characterized the situation in 1983:

> The Ministry of Ferrous Metallurgy each year provides no more than 15 to 17 percent of the new forms of rolled steel required by our industrial branch, and the actual delivery record is still worse. During 1976–80, the enterprises of the Ministry of Heavy Transport Machine Building received only 43 of the 176 forms of rolled product that they required.

Figure 1

USSR: Planned Versus Actual Production of Ferrous Metals, 1970-85



The limited availability and variety of quality steels, in turn, result in poor reliability and low efficiency of domestically produced machinery and equipment. For instance, transformers built with poor quality sheet have high energy losses. Metal input and production costs for machinery and equipment are also higher as a result of the poor quality and narrow assortment of steel products. The Soviet press reports that replacement of unavailable shapes and sizes of rolled steel products with larger sizes is a widespread practice at machine-building enterprises. Additional waste occurs when equipment designers, with a distrust of steel quality, apply a "correction factor" to their designs. Largely because of these practices, machines in the USSR outweigh their Western counterparts by as much as 25 percent.

Gorbachev seized the opportunity during a conference on science and technology in June 1985 to soundly criticize the steel industry's past performance, putting the blame on inefficient allocation of capital investment. Half of the 50 billion rubles of investment spent by the industry during the past 15 years was channeled into new construction, largely to expand basic sectors such as iron ore mining and pig iron production at the expense of reconstructing downstream production facilities to improve the quality and assortment of finished steel products.[1] As a result, the USSR has had to rely increasingly on imports to meet its domestic requirements for finished steel.[2]

Gorbachev followed up his criticism of the industry by sacking the Minister of Ferrous Metallurgy, Ivan Kazanets, in July 1985. His replacement, Serafim Kolpakov, who was first deputy of the ministry from 1981 to 1985, has promised that modernization by "technical reequipment" would be the wave of the future.

IV. The Current Steel Modernization Program

We have recently taken some far-reaching measures with respect to the cardinal issues of economic growth. I mean the resolutions calling for a fundamental reorganization of metal production. . . .—Mikhail S. Gorbachev at a June 1986 CPSU Central Committee meeting.

With modernization of the steel industry virtually as important as modernizing machine building itself, Moscow has adopted a wide-ranging program for reequipping the industry. In comparison with past efforts that focused on increasing production capacities, the current plan emphasizes plant renovation and replacement of outmoded equipment, specifically by:

—Reconstructing older steel plants.

—Replacing open-hearth steelmaking furnaces with basic oxygen or electric furnaces.

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[1] The term "reconstruction" is used loosely by the Soviets and includes replacement of equipment and facilities, renovation of existing equipment, and creation of completely new facilities to correct disproportions in capacities of various stages of the steelmaking process at a plant. According to the Soviet press, in recent five-year plans only 1 percent of investment went toward replacing iron-melting, steel-smelting, and rolling capacity. The few metallurgical machines taken out of service since 1975 were 2 to 2.5 times older than their design life. Soviet literature reports that, meanwhile, repair expenditures for maintaining existing equipment in working condition are increasing each year. In 1983, repair expenditures exceeded allotted capital investment in the industry by about 35 percent.

[2] The value of hard currency imports of finished steel products increased from about $600 million during 1966–70 to about $17 billion in 1981–85.

—More than doubling the share of steel continuously cast by 1990.

According to the Soviet press, 50 percent of investment in ferrous metals during 1986–90 will be used to renew existing plants, 30 percent will go toward improving product variety and quality, and only 20 percent will finance capacity expansion. This is in sharp constrast with past five-year plans, which allocated up to 75 percent of investment to capacity expansion (see table 1).

TABLE 1.—USSR: CAPACITY ADDITIONS IN FERROUS METALLURGY, 1976–85

[In million tons]

	1976–80 annual average	1981	1982	1983	1984	1985
Pig Iron:						
Total capacity	1.1	0.4	0.3	0	0	0
Reconstruction	0.2	0.4	0.3	0	0	0
New enterprises and expansion	0.9	0	0	0	0	0
Crude steel:						
Total capacity	2.9	1.3	2.4	0.3	2.2	0.9
Reconstruction	1.1	0.1	2.4	0	0.1	0
New enterprises and expansion	1.8	1.2	0	0.3	2.1	0.9
Rolled steel products:						
Total capacity	1.5	2.2	0.8	1.6	1.5	1.3
Reconstruction	0.1	0.6	0.2	0.2	0.4	0.4
New enterprises and expansion	1.4	1.6	0.6	1.4	1.1	0.9

Source: Narodnoye khozyaystvo SSSR, various years.

The 1986–90 Plan provides further details on the new program's implementation. Overall gains in output are to be achieved not with increases in production of either inputs such as coke and pig iron or in the size of the labor force, but with increases in labor productivity and resource savings.

Savings of Rolled Steel Products

The 12th Five-Year Plan calls for total savings of 12–14 million tons of rolled steel, mostly in machine building and construction. If this target is to be achieved, total consumption in 1990 would be 12–14 million tons less than that which would have been obtained if 1985 efficiency standards had prevailed. Resource conservation has been espoused before, and the Soviets have achieved some recent success. A leading Soviet journal reported, for example, that the use of new types of steel for the walls and roofs of railroad freight cars during the last 10 years has reduced metal consumption by as much as 200 kilograms per car. Additionally, design changes have reduced the weight of the load-bearing structures of freight cars by 20 to 25 percent. According to the official Soviet statistical handbook, the USSR achieved about 90 percent of the rolled ferrous metals savings—8.6 million tons—designated for the 11th Five-Year Plan (1981–85).

Four recurrent themes appear in the Soviet press as ways to achieve the 1990 goal of reducing rolled steel consumption in machine-building:

—Reorganize the structure of rolled metal output and increase the relative share of "progressive forms" of steel products, including cold-rolled sheets, heat-treated steel, low-alloy steel, sheets with protective coatings, and high-precision shapes.

—Modernize the technology for the manufacture of steel products.

—Design equipment and facilities that make more efficient use of materials.

—Develop the use of substitutes for steel such as ceramics, plastics, chemical fibers, aluminum, and composite materials.

Greater use of numerically controlled machine tools and minicomputer-controlled metal-cutting machinery would reduce waste from cutting steel sheet. According to the Soviet press, the use of heat-treated steel in machine building reduces steel consumption by 25 percent, and only 15 to 20 percent of demand for this steel is being satisfied. Although substitution possibilities in machine building are limited, the Soviets want to make additional use of aluminum and plastics to decrease weight and increase resistance to corrosion. According to another journal article, under Soviet conditions one ton of plastic structural materials can replace as much as 4 to 5 tons of rolled sheet in machine building.

Soviet press comments indicate that substitution will be the main method for saving metals in construction during the 12th Five-Year Plan. Greater use of ceramics, composites, and certain types of concrete not only can reduce consumption of steel, but can result in lighter, stronger structures. The potential for saving metal through other methods also is high. For example, a survey recently done by the USSR State Committee for Construction and the Ministry of Ferrous Metallurgy examined 432 designs for pipe systems in 11 branches and found that many planned to use thick-walled pipe when it was not necessary. The Soviets estimate that more efficient use of steel pipe would result in an annual savings of about 370,000 tons.

The USSR, however, probably will not be able to tap enough of this existing potential to reach the 12th Five-Year Plan savings target. A key to the success of the program is for the ferrous metals industry to provide the proper mix of steel products, but an Izvestiya article in June 1986 reported that metallurgical enterprises had not fulfilled annual plan targets for the production of almost one-third of the economical types of metal. Additionally, enterprises are unlikely to experiment with new designs given the tremendous push for increased machinery production. For example, several machine-building ministries were criticized for backlogs in producing newly-designed equipment that uses less metal. A question also exists as to whether steel-consuming industires can handle certain high-quality steel shapes. For example, a change in the composition of metalworking equipment will be needed to make use of increased production of flat steel.

The emphasis on resource savings is illustrated in Moscow's call for average annual increases of 4½ percent in industrial production and 7½ percent in machine-building and metalworking output with less than a 2-percent average annual increase in rolled steel products during the plan period.[3]

According to statements by senior Soviet officials, priority in reconstructing steel plants during 1986–90 will be given to facilities constructed before World War II such as those at Magnitogorsk (see table 2):

—The Soviets plan to replace 30 million tons of open-hearth capacity with basic oxygen or electric furnaces over the next five years.[4] According to a Western metals journal, former Minister Kazanets stated that the widespread use of open-hearth furnaces—which are more costly to operate and more restrictive in output—constitutes the biggest bottleneck to improvement of the steel industry's overall performance. New facilities to house the new furnaces will have to be built at most, if not all, of these plants because existing structures are too small.

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[3] CIA analysts estimate that during 1981–85, the output of rolled steel products rose by 1 percent per year while industrial production and machine-building and metalworking output increased only 2 and 1½ percent, respectively.

[4] There are three basic types of steelmaking furnaces: open-hearth, basic oxygen, and electric. The Soviets still rely on the outmoded open-hearth furnace for more than one-half of their steel production, in sharp contrast with Western countries. In 1985, the United States produced only 7 percent of its steel in open-hearth furnaces, and none are now being used in West Germany and Japan. Although only a very small share of investment in steel production during 1971–85 went into building new open-hearth furnaces in the USSR, existing furnaces were maintained through repair and modernization.

—All new steelmaking shops, including those at plants undergoing modernization, are to be equipped with continuous casting equipment.[5]

—A Soviet journal reports that rolling mills and pipe-producing shops will be upgraded by removing outdated equipment, reconstructing some existing units, and creating new facilities. Chairman of the Council of Ministers Nikolay Ryzhkov has indicated that 70 rolling mills will be reconstructed and 38 will be decommissioned. Improvement of rolling mills is a key to providing the 500 types of new steel products called for in the five-year plan.[6]

TABLE 2.—USSR: SELECTED STEEL MODERNIZATION OBJECTIVES

Complex	Re-equip or build coke plants	Increase capacity of blast furnaces	Replace open-hearth furnaces	Increase continuous casting capacity	Re-equip or build rolling mills	Build new finishing lines
Magnitogorsk [1]		XX	XX	XX	XX	
Dneprodzerzhinsk			XX	XX		
Kuznetsk [1]			XX	XX		
Novolipetsk		XX			XX	XX
Petrovsk			XX	XX	XX	
Liepaja [1]			XX	XX		
Orsk-Khalilovo	XX	XX	XX	XX		
Karaganda				XX	XX	XX
Zhdanov (Ilyich)					XX	
Serp i Molot					XX	
Rustavi					XX	

[1] Indicates that reconstruction projects are specifically mentioned in the 1986–90 Plan directives approved by the Supreme Soviet in June 1986

Despite the emphasis on reconstruction, some new capacity is to be added in 1986–90, often with the assistance of Western firms. The plan calls for capacity additions at plants in Orel, Zhlobin, Volzhskiy, and Oskol. Additional output is planned to come from an electrical-grade steel shop at Novolipetsk, scheduled to start production in 1986 and from a new minimill at Komsomol'sk na Amure, which was commissioned in late 1985.[7] The 1986–90 Plan

[5] In the traditional steelmaking process, molten steel is poured from furnaces into large rectangular molds to form ingots. After cooling, the ingots are mechanically pulled away from the molds and placed into reheat furnaces to raise the temperature of the metal so the ingots can be rolled into primary shapes—slabs, blooms, and billets. In the continuous casting process—which the Soviets pioneered—molten steel is poured directly into molds from which primary shapes are directly cast and then rolled. This process saves energy and labor and produces steel that is more homogeneous. The amount of steel continuously cast in the USSR has been growing at an average annual rate of 7 percent since 1970 to more than 18 million tons in 1983 (about 12 percent of total crude steel production), the last year for which data are available. This progress is modest when compared with the West where about one-third of US steel and over two-thirds of Japanese and West German steel is continuously cast. Because the maximum benefits of continuous casting are realized only when it is used with basic oxygen or electric furnaces, the slow replacement of open-hearth furnaces has limited the increased use of this technology. The lag in introducing more continuous casting equipment has also hampered Soviet efforts to improve yield—the ratio of rolled steel production to crude steel production—in steelmaking operations.

[6] Old and obsolete rolling mills in the USSR have been the main obstacle to expanding the variety of rolled products. Although costs at these mills are high and labor productivity low, retirement has been slow.

[7] A minimill is a relatively small steel plant that contains electric furnaces and continuous casting and rolling equipment. Because the raw material for steelmaking in a minimill is normally scrap, these facilities do not have the coke ovens or blast furnaces used to make pig iron at a fully integrated steel plant. The annual production of a minimill is usually between 50,000 and 500,000 tons of a limited variety of rolled steel products.

also includes plans to commission new manganese and iron ore mining capacity to help offset production declines caused by falling ore grades and mine depletion in older basins.

V. Roadblocks to Modernization

A. Investment Constraint

The current steel modernization program seems to be focused on the right elements to improve Soviet steel production, but the cost of the program may outstrip the investment resources available for it.

—Emphasis on renovation and replacement of steelmaking furnaces and rolling mills could improve product quality and variety, but will require large outlays for new equipment and, in many cases, expenditures for construction of new plant facilities to house the equipment. Additionally, Soviet literature reports that reequipment has been limited in the past because the cost of new equipment has grown more rapidly than increases in the technical level and reliability.[8]

—Western-supplied *turnkey* projects could be put into operation more quickly than both domestically supplied or Western-supplied *nonturnkey* facilities, but hard currency constraints likely will limit the number of such projects.

—Stressing resource savings and increased use of steel scrap could limit the use of scarce raw materials, such as iron ore and coking coal, but substantial savings must await acquisition and installation of costly new, more efficient metallurgical equipment. Moreover, as in the past, investment may have to be diverted from improvement of rolling and finishing processes to the iron ore sector. During 1976–80 almost 30 percent of investment in the ferrous metals industry had to be allocated to iron ore production and beneficiation to offset the declining quality of ore.

Thus, while the Soviets seem to be attacking key problems that have long plagued the steel industry, success is dependent largely on how much investment can be made available quickly for renovating old plants and building new ones as well as for acquiring modern metallurgical equipment. Investment in ferrous metallury was slighted during 1981–85; it will have to increase sharply in 1986–90 to provide for the sector's modernization. Although Moscow planned to increase investment in ferrous metals by 30 percent in 1986, it is doubtful that such an increase can be sustained during 1987–90. Increases in total investment throughout the economy are slated to average only 5 percent annually during 1986–90, and competition among the various sectors is keen. In a recent speech to the Supreme Soviet, Ryzhkov stated that 80 percent of the total increase in investment in 1986–90 will be allocated to support the Food and Energy Programs, the development of civilian machine building (presumably including metallurgical machine building), and expansion in output of electronic and chemical products.

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[8] Prices for metallurgical equipment increased 130–220 percent in 1982 without substantial increases in the quality of the equipment.

B. MACHINERY CONSTRAINT

Moscow also will face tough problems trying to improve the quality of domestic machinery which is often unreliable and technologically out of date.[9] According to *Pravda*, only about 2 billion rubles were spent on development of metallurgical machine building in the last five-year plan, while five times that amount was spent on the repair of metallurgical equipment during the same period. The reliability of metallurgical equipment is especially important because incapacitated units can often disrupt the whole steelmaking production process because of its continuous nature. Improvements in metallurgical equipment production will be further inhibited because such equipment is not produced at specialized plants but as a sideline at heavy-machine-building enterprises. *Pravda* reports that at several of these plants the proportion of metallurgical equipment in the total volume of output is declining.

Workers and management at machine-building plants generally lack appropriate incentives for producing metallurgical equipment, especially the complex and labor-intensive machinery needed for rolling mills and finishing operations. But Gorbachev's emphasis on an immediate acceleration in economic growth leaves little or no slack in any facet of the machine-building industry. Indeed, the increased pressure on plant managers to boost current production will inhibit innovation that carries any risk of failure and will reinforce the tendency to reproduce the same pattern of output that has prevailed for years, only faster and—unless major gains are made in quality control—perhaps in a more slipshod manner.

C. SPECIAL PROBLEMS OF RENOVATION

In addition to the difficulties of supplying new and better machinery, a program based on reconstruction and technical reequipment poses particular difficulties for the steel industry. Managers of machine-building plants prefer to manufacture serial, standardized equipment, but under the current modernization program, much of the new equipment must be custom made to fit into existing buildings at plants under renovation. Moreover, the renovation strategy has traditionally been resisted by managers of steelmaking enterprises because the downtime required to replace old machinery, as well as the uncertainty inherent in new production processes, threatens their ability to achieve short-term performance goals. Renovation of rolling mills, for instance, usually requires that the facility be shut down.[10]

Of equal concern to enterprise managers may be how quickly workers adapt to the use of the new equipment, which often is more complex and requires more training to operate and maintain. According to a Soviet radio broadcast, the Ministry of Ferrous Met-

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[9] For example, economist Abel Aganbegyan was recently critical of a new electric furnace shop constructed at the Kuznetsk Metallurgical Plant that does not use the latest technology.

[10] In some instances, shutdown is not required. Because most new basic oxygen and electric furnaces probably will be housed in new facilities, the Soviets will be able to continue basic steel production from existing open-hearth furnaces until they are ready for replacement. After two basic oxygen furnaces are built at Magnitogorsk, for example, the Soviets report that an open-hearth shop at the plant will be phased out. Although this will help keep quantity up during renovation, it will do little or nothing toward improving quality in the usual drawn-out construction period.

allurgy intends to strenghthen the training of the labor force by means of handing over experience from one worker to another and by sending people to special training courses. But intentions may not be enough.

Appropriate incentives must also be given to construction firms which, according to a *Pravda* article, have generally steered clear of renovation projects because they tend to be more labor intensive than when construction is started from scratch. Many construction trusts are already suffering from labor shortages. A Soviet broadcast in mid-1985 reported that the Zhdanov Metallurgical Construction Trust, the main contractor for renovation work at the Azovstal' plant, was behind schedule in rebuilding a rolling mill because of a manpower shortage. Earlier last year, the Soviets reported a shortage of workers for assembling new rolling equipment at the Karaganda steel plant.

D. LIMITED HELP FROM ABROAD

Given the difficulties the Soviets are likely to encounter with the domestic supply of modern metallurgical machinery, Moscow almost certainly will turn to its CEMA allies, particularly East Germany and Czechoslovakia, to supply additional equipment. The Soviets have been importing East European metallurgical equipment for years, particularly for rolling mills, which often is of better quality than domestically produced equipment (see table 3). East Germany's Sket has supplied about 30 rolling mills that manufacture 17 percent of Moscow's rolled steel products and is slated to renovate nine light-section rolling mills in the USSR during 1986–87. Sket currently is supplying the rolling equipment for the minimills at Rybnitsa and Komsomol'sk na Amure. The Western press reports that the design for this equipment is similar to the rolling mill built by an Austrian firm at the Zhlobin minimill.

TABLE 3.—USSR: IMPORTS OF METALLURGICAL ROLLING EQUIPMENT, 1975–85

[In millions of dollars]

	1975	1980	1981	1982	1983	1984	1985
Total	211	486	429	579	443	404	446
Developed countries	90	184	157	244	199	109	184
CEMA countries	120	284	252	315	200	263	227
Czechoslovakia	72	193	165	193	127	109	127
East Germany	42	72	67	104	55	129	74
Hungary	6	19	20	18	18	19	26
Poland						6	
Other	1	18	20	20	44	32	35

Source: Vneshnyaya torgovlya SSSR, various years.

It is questionable how much additional high-quality equipment Eastern Europe can provide. Moscow already absorbs a large share of East European machinery production, and most of these countries lack the capacity to expand exports to the USSR much further without cutting into their exports to the West. Thus, it is unlikely that Moscow will be able to depend on its CEMA allies to compensate fully for the shortcomings of Soviet domestic machine building.

Undoubtedly the Soviets will turn to the West to purchase equipment for some of the projects underway or planned, but they simply cannot afford to import all the needed equipment. The blow dealt to Moscow's main source of hard currency revenue by the collapse of world oil prices will limit Soviet foreign exchange spending to items of the highest priority, probably for the rest of the decade. The volume of future imports of Western equipment is likely to depend largely on the terms Moscow is able to negotiate with Western firms. Moscow has an excellent credit rating and may push for additional loans with lower interest rates and longer repayment terms for pending projects.

Moscow recently decided to allow greater Western participation in future joint venture projects including foreign equity, increased management and quality control, repatriation of profits, and other prerequisites to make such ventures attractive to Western firms. Such arrangements could have several advantages for the Soviets:

—A management role for the Western firm would facilitate the transfer of technical know-how related to organization and management of production and the use of advanced technology, knowledge not easily transferred through traditional equipment purchases.

—A long-term equity relationship with a Western firm could allow for automatic updating of production lines to keep up with changing Western steelmaking technology. At a minimum, a vested interest by the Western firm—backed by sustained on-site presence—could improve the use of Western equipment and technology.

—Quality control by the Western partner could help assure that steel products come close to, if not meet, world standards.

—Such arrangements would allow for the transfer of Western technology at little or no hard currency cost to the Soviets until after production begins.

Despite these potential advantages to Moscow, Western steel firms are unlikely to rush to enter into such joint ventures. Years of dealing wth the cumbersome Soviet bureaucracy, poor-quality Soviet raw materials and semi-finished goods, and negotiations that go on interminably will make most Western businessmen wary. Moreover, the Soviets themselves are apt to approach such negotiations cautiously. Granting the amount of control over production processes that would probably be required by the Western firms would go against the grain of most Soviet managers. At present, it appears that there is still a considerable amount of uncertainty among mid-level Soviet officials over what exactly such joint ventures would entail.

VI. Outlook and Implications

On balance, the Soviets will likely fall far short of meeting the modernization goals for the steel industry, although some progress will be made. A greater share of steel will be produced in modern furnaces—basic oxygen and electric—and more of this steel will be continuously cast. These steps will improve the efficiency of the steelmaking process and help the Soviets meet their goals of in-

creasing rolled steel output without increasing production of some inputs, which is essential if investment is going to be concentrated on upgrading metallurgical equipment. Moreover, less dependence on outmoded open-hearth furnaces will give the Soviets more flexibility to produce additional quantities of specialized alloy steels, which cannot be produced in these furnaces.

Completion of some of the new and renovation projects planned during 1986–90 may help meet demands of key sectors of the economy. For example, when the plant at Volzhskiy reaches full capacity, it will provide almost 10 percent more seamless pipe to the economy than was produced in 1985. Moreover, pipe from this plant should prove more reliable in the oil and gas industries and could lead to fewer delays in drilling and developing new oil wells.

Despite some improvements, the Soviet steel industry will face too many obstacles to fully meet the demands of the economy during 1986–90. In addition to problems with domestic machinery supply and factors within the system that are likely to inhibit renovation, Moscow will not be able to count on much help from its CEMA allies or on a sharp upsurge in purchases of Western equipment and technology. If the stock of metallurgical plant and equipment is not modernized on a large scale, the industry's ability to conserve raw materials will be limited and investment will have to be channelled into expanding iron ore production and beneficiation. As a result, the amount of new and better steel products flowing from the industry will fall well below that demanded, and we can expect to see:

—Continuing complaints from various ministries (especially the machine-building ministries) about inadequate variety and quality of steel products which, in turn, will inhibit progress in modernizing the machine-building sector—the centerpiece of Gorbachev's industrial modernization program.

—Machines that continue to outweigh their Western counterparts, perform fewer functions, and need to be repaired or replaced more often—thus siphoning scarce resources away from modernization and into capital repairs.

—Continued need for imports of many Western steel products, such as plate and sheet for the machine-building branches and pipe for the oil and gas industries, adding to the strain on dwindling hard currency resources.

Moscow's continued dependence on Western imports for quality steel products will be particularly vexing to the leadership in view of its hard currency limitations. In the past, Moscow has been able to afford both steel products and steelmaking equipment. Soviet planners will have to weigh carefully the tradeoffs between purchasing Western plant and equipment to upgrade the technological level of the steel industry and importing Western steel products to meet the immediate needs of key machine-building and energy-producing sectors.

Cutbacks in Western equipment purchases in favor of steel products would slow further the pace of steel modernization and widen the gap between Soviet and Western steelmaking technology. Even if the Soviets opt to continue purchases of Western steelmaking equipment, progress in modernizing the USSR's steel industry is

not likely to proceed fast enough to keep pace with developing technologies in the West. Indeed, research now underway in Western Europe, Japan, and the United States promises innovative new technologies that will fundamentally change the way steel is made in the 1990s.

SELECTED ADVANCED STEELMAKING TECHNOLOGIES

Technology	Description	Major Advantages	Status in West
Direct-current arc furnace	Process in which a direct current passes down an electrode through an arc into the metal charge.	33-to 50-percent reduction in electrode consumption. less frequent need for refractory maintenance. small degree of energy conservation.	Limited-scale commercial application.
Continuous-charging electric furnace	Process in which raw materials are added on a continuous rather than a batch basis.	150-percent increase in labor productivity. 30-percent reduction in electricity consumption. 40-percent reduction in electrode consumption. 50-percent reduction in manpower costs.	Do.
Combined-blowing oxygen furnaces	Steelmaking processes that combine the advantages of top-blowing and bottom-blowing oxygen furnaces.	flexibility for greater scrap usage	Development and limited-scale commercial application.
Ladle metallurgy (argon-oxygen decarburization, vacuum degassing and refining, and electron-beam remelting)	Processes that remove impurities from either molten metal poured directly from conventional furnaces or remelted steel.	increased quality control increased labor productivity	Used extensively for alloy steel production but gaining wider use in production of carbon steel.
Horizontal continuous casting	Continuous casting process that uses horizontal molding machines rather than curved.	decrease in internal cracks reduction of inclusions more efficient at producing smaller products.	Limited-scale commerical application.
Hot charging and direct charging to the hot-rolling mill	Hot charging allows only some cooling, follwed by a minimum of reheating, before charging to the rolling mill. Direct charging process sends the semifinished steel directly from the casting machine to the rolling machine without reheating.	substantial energy savings increase in yield	Advanced R&D.
Direct iron smelting	Process to replace blast furnaces and coking and sinter plants. Iron reduction is carried out in a separate chamber from smelting, allowing gasification of ordinary coal both to create reduction agent and heat needed for smelting.	reduction in operating costs reduction in capital costs use of ordinary coal instead of metallurgical coal.	Pilot plant (contract awarded in 1985 to build first commercial plant).
Near-net-shape casting	Process to extend today's continous casting of semi-finished steel to cast either a thin slab 1 to 2 inches thick or to directly cast steel strip 0.1 inch in thickness.	substantial energy savings reduction in labor costs reduction in capital costs improvement in quality	Testing (commercial application of thin slabs, 3 to 5 years; thin strip 10 to 15 years).

Thus, the Soviets will need to acquire these technologies either through their own research and development (R&D) or from the West. Moscow will want to pursue these new technologies because they offer felxibility to use more abundant resources or save on energy use.[11] Direct iron smelting would be especially beneficial for the Soviet steel industry because it eliminates the need for coke. Shortages of coking coal have constrained Soviet steel production for some time, and this problem will probably grow worse in the future. Technologies such as near-net-shape casting, continuous-charging electric furnaces, and hot or direct charging for rolling mills promise substantial energy savings. Moreover, many of these new technologies cost less per ton of capacity than conventional processes. Soviet steel authorities are likely to be attracted to any technology that not only cuts operating costs but also stretches limited investment funds.

In the meantime, the Soviet steel industry will continue to come up short in terms of both the regime's expectations and the needs of the machine-building sector. The failure to make major improvements in the steel industry over the next few years will make industrial modernization more difficult and protracted, increasing the risk that Gorbachev's ambitious modernization goals for the remainder of the decade will not be met. As the Soviet leader is able to assess how modernization is faring, he may be in a position to better plan improvements that could be implemented in the 1990s. However, prolonged delays and setbacks to current modernization goals will also increase pressure on the regime to either back off its ambitious program or make more fundamental changes in the system that might provide both the incentives and the resource slack necessary for meaningful improvements to occur.

[11] The Soviets are already working with West Germany's Krupp Industrietechnik to develop a 100-percent scrap-based oxygen furnace to limit the use of iron ore.

THE SOVIET PETROCHEMICAL INDUSTRY

By Matthew J. Sagers* and Theodore Shabad**

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I. Summary

This study examines the development of, as well as the prospects for, the Soviet petrochemical industry, emphasizing a few major bulk organic chemicals. Although the Soviet programs for industrial modernization in the 12th Five-Year Plan largely focus upon the machine-building sector and the construction industry, the petrochemical industry is in a crucial supporting position, as it is a supplier of intermediate chemicals used to produce synthetic materials and many other end-products required by the modernization program. The advanced nature of these types of products and their growing use in the machine-building and construction industries make the performance of the petrochemical industry an important determinant for the success of the 12th Five-Year Plan goals. The petrochemical industry also is relatively energy-intensive and a major user of petroleum raw materials, so it is an important sector to examine in the context of the Soviet drive to economize on these raw materials.

The Soviet petrochemical industy is relatively new, really dating only from the 1950's, and is still small compared to that of other countries. Early development focused almost exclusively on producing synthetic ethanol for the synthetic rubber industry, and it was

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not until the 1960's that the industry began to diversify to supply a wider range of intermediates to a broader range of synthetic materials industries. Equipment began to be imported for the industry in the 1970's, and much of the recent expansion and diversification in the industry has been based on imported equipment and designs, mostly from the West. Currently, about 30 percent of ethylene, nearly 50 percent of benzene, over 90 percent of xylenes, and about 65 percent of methanol are produced on imported Western equipment.

In the 12th Five-Year Plan, the expansion of basic petrochemicals is projected to continue at a fairly rapid rate, largely driven by the demand for modern plastics and fibers. However, this expansion may be constrained by the availability of equipment and feedstocks. The possible shortage of equipment stems from long-existing weaknesses of the domestic chemical engineering industry. It also has been losing ground since the 1970's, with much of its capacity being sapped to meet high priority needs for the oil and gas industries. Imports traditionally filled the gap, but no imports of equipment seem to be on the horizon for the 12th Five-Year Plan. Feedstock shortages are already a problem for many plants, mostly due to the dramatic shifts in hydrocarbon production among the regions since the 1970's, as well as the overall tightness in petroleum supplies. The industry also has been very slow to follow world-wide trends in shifting regionally to utilize more gaseous feedstocks, now coming mostly from West Siberia.

II. Introduction

The new 12th Five-Year Plan (1986–1990) calls for a massive transformation or restructuring (*perestroika*) of the Soviet economy through an industrial modernization program to improve overall growth rates (*uskoreniye*) and the quality of output.[1] Although much of this is to be necessarily focused upon the machine-building sector (the economy's basic source of capital goods), the petrochemical industry is in a crucial position to support the Soviet programs for industrial modernization as a supplier of intermediate chemicals used to produce synthetic materials and many other end-products required by the modernization drive.

The advanced plastics and synthetic fibers are particularly important elements in modernizing the machine-building industry and construction, two sectors specifically singled out for "transformation" in the 12th Five-Year Plan. After the chemical industry itself (for manufacturing chemical fibers and paint ingredients), they are the largest consumers of plastics and resins. The larger is machine-building, accounting for 26 percent of domestic plastics consumption in 1983. Within machine-building, the largest single consuming sector is the electro-technical industry, one of the key areas in Gorbachev's modernization plans. It alone utilized nearly half of machine-building's plastics consumption, or 12 percent of the the USSR total.[2] The construction industry also used 12 per-

[1] Ed A. Hewett, "Gorbachev's Economic Strategy: A Preliminary Assessment," *Soviet Economy*, Vol. 1 no. 4 (October-December, 1985), p. 285–305; *Pravda*, June 19, 1986.

[2] V.V. Listov, Khimicheskaya promyshlennost' v odinnatsatoy pyatiletke. Moscow: Khimiya, 1984, p. 14.

cent of Soviet plastics, and its consumption has been growing very rapidly in recent years. For chemical fibers, the dominant user is light industry (accounting for 76.5 percent of consumption in 1983), basically for textiles and fabrics, but 9.8 percent of these fibers are used to produce various technical manufactures for other industries (i.e. electronics and optics), and another 19.5 percent is for tire manufacture.[3]

Also, the petrochemical industry is relatively energy-intensive and utilizes large amounts of petroleum raw materials and energy, so it is an important sector to examine in the context of the Soviet drive to economize on these raw materials and energy sources.

III. Petrochemical Production and Raw Materials

A. NATURE OF THE INDUSTRY

Petrochemicals are simply chemicals manufactured from feedstocks obtained from oil and gas, rather than coal or agricultural products. Petrochemical *products* are used in a wide variety of applications, such as making plastics, synthetic fibers, synthetic rubber, detergents, paint ingredients, and thousands of other industrial and consumer goods. These various end-use products are derived from a small number of primary and intermediate petrochemicals, and these constitute the principal focus of this paper. Primary petrochemicals are those obtained directly from feedstocks, with few direct end-uses; they are chiefly converted into intermediates and/or finished products.

Three basic groups of hydrocarbons (compounds in which hydrogen and carbon atoms are combined) form the basis for the petrochemical industry: the paraffin or methane series, olefins/diolefins, and aromatics. The paraffins comprise the feedstocks or raw materials used in petrochemical synthesis. These include methane, ethane, propane, butane, and pentane. The feedstock materials which are comprised of these hydrocarbons include natural gas, which is mostly methane; natural gas liquids, which are ethane, propane and the butanes (the liquefied petroleum gases or LPG), pentanes, and natural gasoline (a mixture of the heavier hydrocarbons); and petroleum liquids, which are liquefied refinery gases (propane and butane), naphtha (low-octane gasoline), and gas-oil (heavier distillates in the kerosene-diesel fuel range).

The olefins/diolefins combine readily with other elements, and so form the backbone of modern petrochemical synthesis. The principal olefins are ethylene and propylene, while butadiene is the main diolefin. These primary petrochemcials are manufactured mostly from the high-temperature breakdown, or "cracking", of paraffin hydrocarbons, a process also known as pyrolysis. Ethane, propane, butane, and the heavier paraffins can be "cracked" to olefins, although methane, the chief constitutent of natural gas and the simplest member of the paraffin series, cannot. Methane also is used to produce methanol and ammonia, but in quite different processes, and butane and pentane are used to directly produce butadiene and isoprene, two important synthetic rubber monomers.

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[3] Listov, 1984, p. 18.

The members of the third hydrocarbon group, the aromatics, are also quite reactive, and therefore also are used extensively in petrochemical synthesis. The simplest, but most important, aromatic is benzene; the other major aromatics are toluene and the three isomers of xylene. The principal process used in manufacturing aromatic hydrocarbons is catalytic reforming, also of low-octane gasoline fractions, although a signficiant amount of Soviet benzene also is produced from pyrolysis as a byproduct of olefin manufacture.

B. PETROCHEMICAL FEEDSTOCKS

Although petrochemical feedstocks (the raw materials used by the petrochemical industry) are not a major claimant upon Soviet petroleum resources, petrochemcial needs are significant since the industry requires the light fractions, especially low-octane gasoline (naphtha), that are in relatively short supply.[4] Currently, the USSR relies heavily upon petroleum liquids for petrochemical feedstocks. For example, about three-quarters of pyrolysis feedstocks (i.e., olefin raw materials) are refinery liquids, of which two-thirds are low-octane gasoline (Table 1).

TABLE 1.—PYROLYSIS RAW MATERIALS

(In percent of the total)

Raw material	1960	1965	1970	1975	1977	1979	1980	1985 [1]
Refinery gases and ethane	34.0	17.0	3.0	10.0	n.d.	6.8	n.d.	n.d.
Ethane	n.d.	n.d.	7.5	4.0	6.5	5.1	5.8	6.8
Dry (refinery) gases	n.d.	n.d.	(2)	4.3	n.d.	1.7	n.d.	n.d.
LPG and dry (refinery) gases	n.d.	n.d.	n.d.	n.d.	24.4	n.d.	20.7	11.1
LPG (Kaviev)	n.d.	n.d.	55.6	32.7	n.d.	20.9	n.d.	n.d.
LPG (Rabkina)	45.0	61.0	40.5	27.0	n.d.	n.d.	n.d.	n.d.
Gasoline and gas-oil	21.0	22.0	56.5	63.0	69.1	72.3	73.5	82.1
Gasoline (naphtha)	(2)	13.0	20.5	40.8	62.0	60.1	67.2	82.1
Gas-oil (kerosene, diesel fuel)	21.0	9.0	16.4	18.2	7.1	12.2	6.3	(2)

[1] forecast
[2] negligible, if any
n.d.—no data

Source: 1977, 1980, 1985: I.R. Chernyy, Proizvodstvo syr'ya dlya neftekhimicheskikh sintezov. Moscow: Khimiya, 1983, p. 13; 1960, 1965, 1970, 1975: A.L. Rabkina et al., Ekonomicheskiy problemy perspektivnogo razvitiya neftekhimicheskoy promyshlennosti. Moscow: Khimiya, 1979, p. 106; 1970, 1975, 1979: G.M. Kaviev et al., Perspektivy proizvodstva i ispol'zovaniya etana v narodnom khozyaystve. Moscow: TsNIITENeftekhim, 1980, p. 7.

Thus, petrochemcial feedstocks comprised 5.6 percent of refinery throughput in 1980,[5] or some 25–26 million tons. This represents about three-fourths of the industry's petroleum requirements, with the remainder used as fuel. Thus, in addition to the 25–26 million tons of petroleum liquids used for feedstocks, another 7 million tons or so were used as fuel. In total then, petrochemical usage accounted for about 8 percent of Soviet petroleum consumption in 1980; however, these 32–33 million tons of feedstocks represented some 13–14 percent of all *light* petroleum products produced, because the output mix of Soviet refineries is dominated by heavy

[4] Matthew J. Sagers and Albina Tretyakova, "Constraints in Gas for Oil Substitution in the USSR: The Oil Refining Industry and Gas Storage," Soviet Economy, vol. 2 No. 1 (January-March, 1986), pp. 72-94; reference on p. 78.

[5] V.A. Proskuryakov and V.L. Klimenko, "Vazhneyshiye problemy nauchno-tekhnicheskogo progressa v neftekhimicheskoy promyshlennosti," in Neftekhimiya. Leningrad; Nauka, 1985, pp. 3-6; reference on p. 4.

products.[6] The bulk of these petroleum liquids are used for manufacturing olefins and aromatics.

IV. Development of the Industry

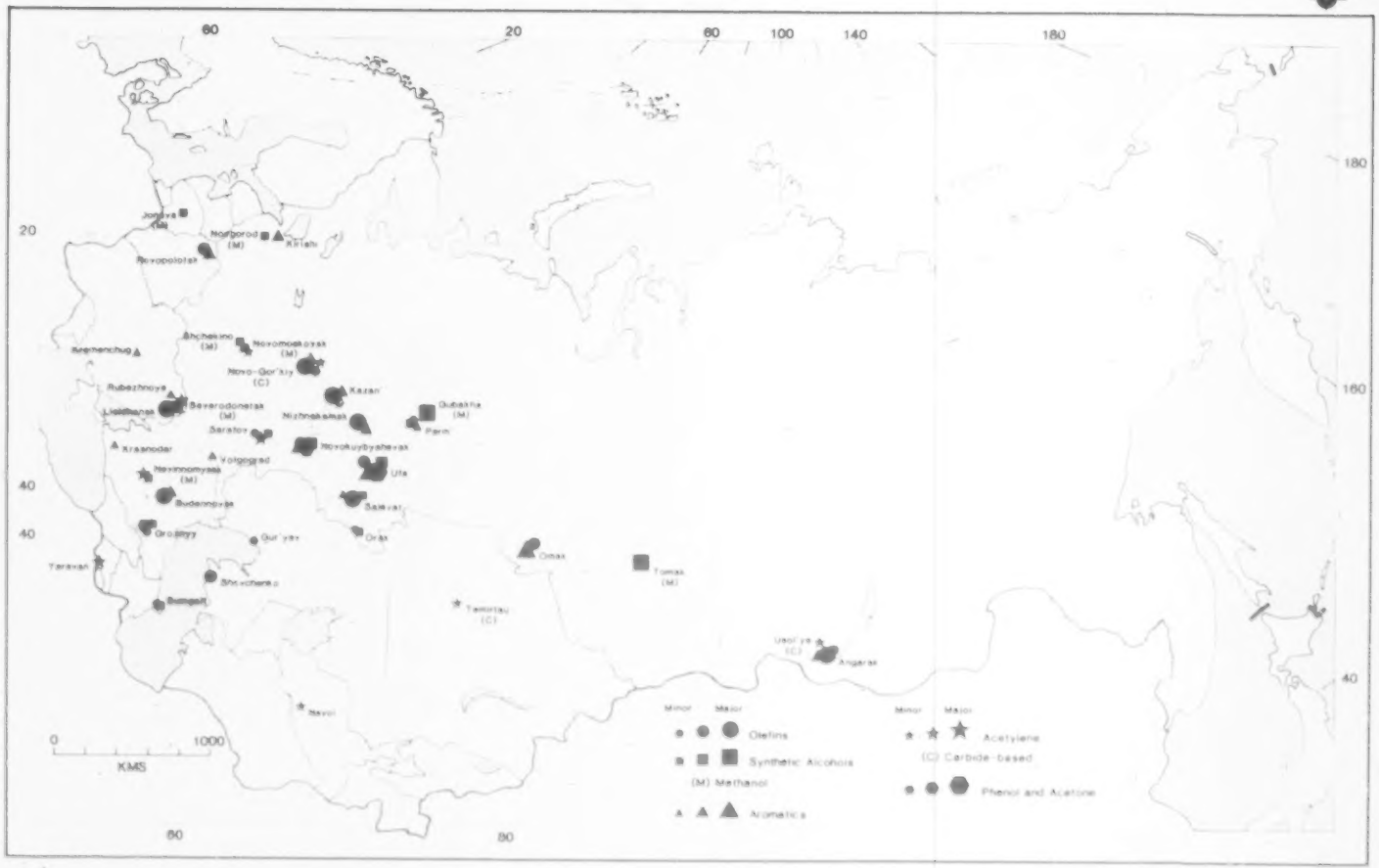
The Soviet petrochemical industry is relatively new, dating really only from the 1950's. Although some use had been made of petroleum-based chemical synthesis in the 1930's and 1940's, this was extremely limited, and the use of petrochemicals on a significant scale came only after World War II.

Early petrochemical developments in the 1950's focused upon production of synthetic ethanol (ethyl alcohol) from ethylene for butadiene manufacture, one of the principal monomers in synthetic rubber. It was not until the 1960's that the industry began to expand and diversify to supply a wider variety of intermediates to a broader range of synthetic materials industries. Its expansion and diversification continued through the 1970's, primarily based on imported equipment and designs (see below). But the industry is still small compared to that in other industrial countries.

A. EARLY ETHANOL PHASE

The USSR's first large-scale petrochemical plants, constructed in the 1950's, produced synthetic ethyl alcohol (ethanol) from ethylene in refinery gases. This early ethanol phase included the construction of synthetic alcohol plants at Sumgait (1952), Orsk (1955), Ufa (first section in 1956, second in 1962), Saratov (1957), Novokuybyshevsk (first section in 1957, second ethanol section in 1963), and Groznyy (first section in 1958, second in 1964) (Figure 1).

[6] Matthew J. Sagers and Albina Tretyakova, Restructuring the Soviet Petroleum Refining Industry, CIR Staff Paper No. 4. Washington, D.C.: Center for International Research, Bureau of the Census, 1985, p. 9.


60
20
60
100
140
180
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160
40
20
Jonava (M)
Norborod (M)
Khlebi
Novopolotsk
Shchekino (M)
Novomoskovsk (M)
Novo-Gor'kiy (C)
Kazan
Rubezhnoye
Severodonetsk (M)
Nizhnekamsk
Dubossary (M)
Perm
Saratov
Novokuybyshevsk
Ufa
Volgograd
Novinnomyssk (M)
Budennovsk
Salavat
Groznyy
Gur'yev
Orsk
Omsk
Tomsk (M)
Shevchenko
Temirtau (C)
Angarsk
Bayol
0
1000
KMS
Minor
Major
Olefins
Synthetic Alcohols
(M) Methanol
Aromatics
Acetylene
(C) Carbide-based
Phenol and Acetone

Ethanol was then the basic starting material for producing the butadiene monomer of synthetic rubber. Thus, ethanol had become an important chemical intermediate when Soviet production of synthetic rubber began on a large scale in the 1930's. At that time, production was based on the hydrolysis of wood, but this was soon surpassed in importance by ethanol production from agricultural raw materials (grain and potatoes).[7] However, the growing demand for synthetic rubber could not be met from agricultural products, and this triggered the post-war transition to the derivation of ethanol from petroleum.

Synthetic ethanol production grew rapidly in the 1950's, from 0.1 million decaliters in 1950 to 41.3 million in 1960 (Table 2). However, growth slowed in the 1960's, and then leveled off in the 1970's. Non-synthetic production evidently collapsed after 1975, and even synthetic production has been affected. Production in 1980 was only 142.2 million decaliters, of which 92.4 million, or 65 percent, were synthetic (petroleum-based) (Table 2).

TABLE 2.—PRODUCTION OF ETHYL ALCOHOL (ETHANOL)

[million decaliters]

	1940	1950	1955	1958	1960	1965	1970	1975	1980	1981	1982	1983	1984
All ethanol	89.9	73.0	n.d.	163.9	170.7	211.1	275.0	[1] 297.0	142.2	n.d.	n.d.	n.d.	n.d.
Synthetic (a)	([2])	0.1	5.3	26.5	41.3	76.0	90.0	95.0	92.4	92.2	92.5	89.8	89.7
Other (b)	89.9	72.9	n.d.	137.4	129.4	135.1	185.0	[1] 202.0*	49.8	n.d.	n.d.	n.d.	n.d.

[1] Planned
[2] No production
n.d.—No data

(a) Petroleum-based
(b) Derived from agricultural products and wood

Source: Synthetic output, 1965–1980: L.A. Kostandov et al., Razvitiye khimicheskoy promyshlennosti v SSSR, Vol. 2. Moscow: Nauka, 1984, p. 1973; synthetic output, 1981–1984: U.N. Economic Commission for Europe, Annual Review of the Chemical Industry. Geneva: Annual; percent synthetic, 1980: Kostandov et al., Vol. 1, 1984, p. 183; synthetic and other, 1940–1965: G.F. Borisovich, Ekonomika promyshlennosti sinteticheskogo kauchuka. Moscow: Khimiya, 1980, pp. 62–63; synthetic output, 1955: E.S. Savinskiy, Khimizatsiya narodnogo khozayaystva i razvitiye khimicheskoy promyshlennosti. Moscow: 1978, pp. 24–25; all ethanol and other, 1970, 1975: V.M. Bushuyev, Khimicheskaya industriya v svete resheniy XXIV s'yezda KPSS. Moscow: Khimiya, 1973, pp. 144–145.

The declining importance of ethanol was due to technological changes in the synthetic rubber industry. In the early 1960's, processes to produce butadiene directly from butane and isobutane, bypassing the ethanol stage, began to be introduced, greatly lessening the need for ethanol. Thus, whereas 94.5 percent of synthetic rubber was derived from ethanol in 1960, only 15.5 percent was in 1970, and only 9 percent in 1980.[8] Ethanol remains a major petrochemical intermediate, however, with important uses in the paint and lacquer industry, pharmaceuticals, and in the production of photographic films, but even by the late 1970's, 60 percent of ethanol still was being used for producing butadiene.

B. THE ETHYLENE CHAIN: BACKBONE OF THE INDUSTRY

Ethylene is the single most important building block in petrochemical synthesis; it remains the pre-eminent base material, both in terms of the range of resulting end-products and in overall

[7] Matthew J. Sagers and Theodore Shabad, "Synthetic Rubber:" Chapter 7 of a forthcoming book on the Soviet chemical industry, 1986b.
[8] Sagers and Shabad, 1986b.

volume utilized. It serves as the base material for producing the three major thermoplastics, as well as synthetic rubber monomers, anti-freeze mixtures, etc.

In 1985, Soviet production of ethylene totalled 2.667 million tons, nearly double what it was in 1975, and 50 percent greater than in 1980 (Table 3). The large increase since 1975 has been due to the introduction of several large-capacity new plants in recent years, many of which have been imported (see below). Despite this recent expansion, ethylene production in 1985 was still less than 20 percent that of the United States, and before 1970, Soviet ethylene production was very limited, increasing from a miniscule 147,000 tons in 1960 to only 799,000 tons by 1970 (Table 3).

TABLE 3.—PRODUCTION OF OLEFINS, AROMATICS AND METHANOL

[Thousand tons]

	1960	1965	1970	1975	1980	1981	1982	1983	1984	1985
Olefins:										
Ethylene	147	480	799	1,366	1,773	2,093	2,132	2,267	2,543	2,667
Propylene	23	116	302	580	824	919	981	1,035	1,098	1,177
Aromatics:										
Benzene	506	697	1,036	1,427	1,644	1,698	1,690	1,853	1,956	1,971
Xylenes	42	94	214	327	459	468	409	559	849	937
Methanol	231	482	1,004	1,447	1,900	2,030	1,989	2,174	2,467	2,850

Sources: Statisticheskiy yezhegodnik stran-chlenov Soveta Ekonomicheskoy Vzaimopomoshchi (SEV). Moscow: SEV, 1986, pp. 96–97; 1976, p. 97. Narodnoye khozyaystvo SSSR v 1985 godu, statisticheskiy yezhegodnik. Moscow: Finansy i statistika, 1986, p. 146; Chernyy, 1983, p. 21.

The Soviet Union's first production of ethylene on anything approaching an industrial scale occurred in the 1950's, based on refinery gases, to make ethanol (see above). The first major ethylene-to-ethanol unit was inaugurated in 1952, at Sumgait, and others quickly followed (see above). Through the 1950's and into the 1960's, ethanol production was the major use of ethylene (Table 4). However, after having been oriented almost exclusively towards ethanol, ethylene production quickly changed direction in the 1960's, mainly towards polyethylene (a major thermoplastic), but also towards ethylene oxide (for glycol production), ethylbenzene (formed by reacting ethylene with benzene and used for styrene production), and the synthesis of vinyl chloride (from ethylene dichloride) and acetaldehyde; the use of ethylene for ethanol declined from about 70 percent in 1960 to 8.8 percent by 1980, while its use for polyethylene rose rapidly, from less than 1 percent in 1960 to 28.8 percent by 1970, and 45.6 percent by 1980 (Table 4).

TABLE 4.—STRUCTURE OF ETHYLENE AND PROPYLENE CONSUMPTION

[in percent of total]

	1958	1959	1963	1966	1970	1975	1980
A. Ethylene:							
Ethanol	69.2	78.0	67.0	61.0	45.3	23.1	8.8
Polyethylene	0.4	[2]	11.0	14.1	28.8	29.5	45.6
Ethylbenzene (styrene)	5.5	3.6	5.5	7.2	3.6	9.5	7.5
Acetaldehyde	([2])	([2])	([2])	([2])	5.0	9.7	9.3
Ethylene oxide (glycol)	13.7	9.3	9.7	6.0	n.d.	n.d.	n.d.
Others	11.2	9.1	6.8	11.7	17.3	28.2	28.8

TABLE 4.—STRUCTURE OF ETHYLENE AND PROPYLENE CONSUMPTION—Continued

[in percent of total]

	1958	1959	1963	1966	1970	1975	1980
Ethylene dichloride	8.5	7.3	5.3	8.9	n.d.	n.d.	n.d.
				1960	1970	1975	1980 [1]
B. Propylene:							
Isopropylbenzene (phenol/acetone)				63.0	49.8	35.6	n.d.
Isopropyl alcohol				35.0	16.3	3.9	n.d.
Polypropylene				[2]	1.5	7.8	n.d.
Butanol				[2]	13.2	19.8	n.d.
Allyl chloride (glycerin)				[2]	6.6	n.d.	n.d.
Acrylonitrile				[2]	5.6	n.d.	n.d.
Propylene oxide				[2]	4.7	n.d.	n.d.
Others (including methylstyrene)				2.0	2.3	26.9	n.d.

[1] Source lists 1980, but provides no data.
[2] Negligible, if any production from ethylene, propylene.
n.d. no data.

Source: Chernyy, 1983, p. 22 for 1970, 1975, and 1980.
L.A. Kostandov et al., 50 let khimicheskaya nauk i promyshlennost'. Moscow: Khimiya, 1967, p. 191 for 1958 and 1963;
N.P. Fedorenko, Voprosy ekonomika promyshlennosti organicheskogo sinteza. Moscow: Nauka, 1967, p. 121 for 1966 and 1959.

But in establishing these new petrochemical-based synthetic materials industries, much of the equipment had to be imported. Currently, well over half of the USSR's acrylic fibers and the acrylonitrile intermediate is produced on imported equipment, about three-quarters of the caprolactam, the intermediate for polyamide fibers (nylon), and almost all of polyester fibers. Among the major thermoplastics, the production of polyethylene is nearly totally dependent upon imported equipment, and about 85–90 percent of polypropylene, some 60–65 percent of polystyrene, and nearly 50 percent of polyvinyl chloride is produced on imported equipment.[9]

The USSR's first polyethylene-oriented ethylene plants were installed in the early 1960's, several of which were based on pyrolysis rather than the separation of refinery gases. Since then, most of new ethylene capacity has been based on pyrolysis, and this manufacturing process now dominates production. These early units were fairly small, but after 1965, larger pyrolysis units, with capacities of 60,000 and 100–120,000 tons, began to be introduced to support the expansion and diversification of ethylene-based synthesis.

The first significant polyethylene-oriented ethylene unit went into operation in 1961 at the Groznyy chemical plant, and the second (based on the pyrolysis of hydrocarbon gases) opened at Salavat in 1962 (Figure 1). Another early pyrolysis-type ethylene unit opened at the Novokuybyshevsk synthetic alcohol plant in 1963. During the 1960's the Ufa petrochemical complex also began producing polyethylene, and acquired several additional ethylene units, of which at least one is a 60,000 ton pyrolysis facility.[10]

The production of ethylene/polyethylene expanded to four other refining and petrochemical centers in the late 1960's: Gur'yev in Kazakhstan, Novopolotsk in Belorussia, Sumgait in Azerbaijan,

[9] Matthew J. Sagers and Theodore Shabad, "Petrochemicals," Chapter 6 of a forthcoming book on the Soviet chemical industry, 1986a.
[10] Sagers and Shabad, 1986a.

and Kazan' (Figure 1). In a somewhat different line of development, the Omsk synthetic rubber plan began producing acetaldehyde from ethylene in 1970, implying some ethylene manufacture there.

Production of ethylene/polyethylene began at the Gur'yev refinery in 1966, based on the separation of refinery gases, with additional capacity being installed in the early 1970's. An ethylene unit, based on refinery gases, went in with Novopolotsk's first polyethylene plant in 1968, and an additional ethylene/propylene separation unit, with a capacity of 60,000 tons per year, was installed at Novopolotsk in 1970 by a British firm. This apparently was the first use of imported ethylene equipment in the USSR. Another 60,000 ton unit was installed at Novopolotsk during the early 1970's, although of the pyrolysis type.[11] Sumgait's second ethylene unit was installed in 1967, the first had been installed in 1952 to support ethanol synthesis (see above), and a polyethylene facility was added to the Kazan' organic synthesis plant in 1965, an expansion which included the installation of an ethylene unit. A second ethylene unit was added in 1967, and ethylene production continued to expand at Kazan' through the 1970's and early 1980's, with a 100,000 ton ethylene unit (apparently Soviet-made) starting up in 1975, and another unit, a 200,000 ton plant imported from Japan, being added in 1982.

Despite the large amount of ethylene being produced at Kazan', it was inadequate to support the plant's rapidly expanding polyethylene output, which in the late 1970's had reached about 30 percent of all Soviet production, or some 150,000 tons. Ethylene was also needed to supply the 30,000 ton ethylene glycol and 60,000 ton ethylene oxide units completed in the late 1970's, using Japanese equipment.

Kazan's additional ethylene needs led to the construction of an ethylene pipeline from the Nizhnekamsk petrochemical complex in 1976; other pipeline segments were added during 1977 to carry ethylene southward from Nizhnekamsk to Ufa, Sterlitamak, and Salavat, creating an ethylene pipeline network.[12] The USSR supplied the pipe, but the design and engineering, as well as ancillary equipment, were provided by several Western firms.[13] The ethylene is used for the production of polyethylene at Ufa and Salavat, and vinyl chloride at Sterlitamak.

Two other domestic 60,000 ton ethylene units were installed in the 1970's, one at Perm' in 1975 and the other at Angarsk in 1977 (Figure 1), while a 450,000 ton ethylene plant, the USSR's largest, began operations in mid-1976 at the huge Nizhnekamsk petrochemical complex. This unit supplies ethylene by pipeline for processing activities at Kazan', Ufa, and Sterlitamak (see above), as well as being utilized locally for producing ethylbenzene and styrene. Units for producing 200,000 tons of ethylene oxide and 7,500 tons of ethylene glycol, both using West German equipment, are under construction.

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[11] Sagers and Shabad, 1986a.

[12] Theodore Shabad, "News Notes," Soviet Geography, Vol. 18 no. 10 (December, 1977), p. 779.

[13] CIA (Central Intelligence Agency), Soviet Chemical Equipment Purchases from the West: Impact on Production and Foreign Trade. ER-78-10554, October, 1978.

The large ethylene plant at Nizhnekamsk is said to be of domestic manufacture, built under license from Tokyo of Japan using a Lummus process;[14] it carries the Soviet designation EP-450. However, most of the components used were actually purchased from abroad rather than manufactured domestically, so the unit also is referred to as "imported".[15]

In addition to ethylene, the Nizhnekamsk olefin plant produces 200,000 tons of propylene, 54,000 tons of butadiene, and 180,000 tons of benzene as co-products. The benzene unit is an add-on using Japanese equipment (pyrotol process); an identical facility was completed earlier at Kazan'.

Large-capacity domestic ethylene units also have been developed in recent years, although some parts (specifically the furnace assemblies) come from Czechoslovakia.[16] These units, known as EP-300's, have capacities of 300,000 tons of ethylene, but also yield about 144,000 tons of propylene and 40,000 tons of butadiene per year. The first of these was introduced in 1978, at Lisichansk, and three more of these units were constructed in the early 1980's, one at the Novo-Gor'kiy refinery at Kstovo in 1981, one at the Angarsk refinery in 1982, and another at Salavat in 1984 (Figure 1). The construction of two others began during the 11th Five-Year Plan, at Novokuybyshevsk and Sumgait; the Sumgait unit was scheduled to begin operations in 1986.

In addition to these domestically-manufactured units, a large ethylene-propylene plant purchased from West Germany went into operation at Budennovsk, in the North Caucasus, in 1980 (Figure 1). The plant has a capacity of 250,000 tons of ethylene, 125,000 tons of propylene, and 100,000 tons of benzene, and supplies a new polyethylene plant. An identical West German ethylene-propylene plant is under construction at Kalush in the western Ukraine to support its large vinyl chloride production. Ethylene now is being supplied to Kalush via a pipeline from Leninvaros in Hungary, which has been in operation since 1974. The Kalush olefin plant is scheduled to begin operating in 1986, and plans call for the direction of flow in the ethylene pipeline to be reversed in 1987, supplying ethylene and propylene to Hungary.[17]

1. Propylene

One of the main co-products of ethylene manufacture is propylene, the industry's second most important monomer. Production in 1985 was 1.177 million tons, up nearly 43 percent from 1980, and double what it was in 1975 (Table 3). Like ethylene, the principal source of propylene in the USSR was at first refinery gases, but now is derived mostly from pyrolysis. The main propylene-producing centers are the large pyrolysis units previously mentioned, which jointly produce ethylene and propylene. Nizhnekamsk produces about 200,000 tons per year, Lisichansk, Novo-Gor'kiy, Angarsk, and Salavat produce about 144,000 tons per year, and the Budennovsk plant produces about 125,000 tons of propylene per

[14] Neftepererabotka i Neftekhimiya, no. 8 (1981), p. 37; no. 7 (1985), p. 25.
[15] CIA, 1978, p. 25; Khimicheskaya Promyshlennost', no. 12 (1984), p. 17.
[16] Neftepererabotka i Neftekhimiya, no. 7 (1981), p. 41.
[17] Sagers and Shabad, 1986a.

year (see above). The smaller pyrolysis units also yield some propylene.

The demand for propylene in the USSR was fairly small until the development of the cumene method for producing phenol and acetone, two widely used intermediates; this quickly became propylene's most important use. By 1959, two-thirds of propylene output was used for making cumene (isopropylbenzene). The production of methylstyrene, an important monomer for synthetic rubber manufacture, began in the late 1950's in a process using propylene, diversifying propylene consumption somewhat through the early 1960's (Table 4). Since then, a variety of other uses have developed, such as polypropylene (a thermoplastic), acrylonitrile (for making fibers), butanol, and propylene oxide (Table 4).

C. AROMATICS

Aromatic hydrocarbons are very important base materials in heavy organic synthesis, second only to the olefins, and are also key blending components in high-octane motor fuels. The simplest, but most important aromatic, is benzene; the three isomers of xylene also are important, while toluene, the remaining major aromatic, is used mostly in motor fuels, although a significant amount is used to produce benzene. Considerable amounts of aromatics also are exported; Soviet exports of aromatics were over 478,000 tons in 1985, nearly three-quarters of which were xylenes.[18]

The production of aromatic hydrocarbons has grown rapidly in the USSR during the last 25 years: benzene production has increased nearly four-fold since 1960, from 506,000 tons to 1,971,000 tons in 1985, and production of xylenes has increased by over 22 times, from a mere 42,000 tons in 1960 to 937,000 tons in 1985 (Table 3). Although no tonnage figures are available, toluene output increased 8.2 times between 1960 and 1980,[19] suggesting a level of production intermediate between benzene and the xylenes. However, aromatics production is still relatively low by U.S. standards; Soviet benzene production is about 40 percent that of the U.S., while xylenes output is only about 15 percent of U.S. production.

Most of the USSR's aromatics are now obtained from the catalytic reforming of gasoline fractions; their extraction from coking ovens is of secondary importance; in the 1970's, nearly 60 percent of benzene, and 90 percent of toulene and xylenes, were produced from catalytic reforming.[20] Thus, aromatics production tends to be concentrated at a few petroleum refineries which have large catalytic reforming units equipped with aromatics extraction. This is known to occur at Ufa, Omsk, Novopolotsk, Angarsk, Salavat, Kirishi, Kremenchug, Novokuybyshevsk and Volgograd, and probably at Baku/Sumgait and Perm' (Figure 1).

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[18] Vneshnyaya Torgovlya SSSR v 1985 godu. statisticheskiy sbornik. Moscow: Finansy i statistika, 1986, p. 26.

[19] I.R. Chernyy, *Proizvodstvo syr'ya dlya neftekhimicheskikh sintezov*, Moscow. Khimiya, 1983, p. 187.

[20] Sagers and Shabad, 1986a.

1. Benzene

Currently in the USSR, 90 percent of benzene is used for producing ethylbenzene (used for making styrene), phenol, and caprolactam (the intermediate for polyamide fibers); nearly half of benzene output is devoted to ethylbenzene manufacture alone (Table 5). Most of the remainder is used in the production of other chemicals, including maleic acid/anhydride, adipic acid, and alkylbenzene. Thus, the chemicals industry itself accounts for practically all of Soviet benzene consumption. This represents a considerable change in benzene consumption patterns since 1959, when the chemical industry used little more than a quarter of benzene output, and within the chemical industry itself, phenol production was then the major consumer, while ethylbenzene accounted for less than 10 percent of all benzene usage (Table 5).

TABLE 5.—STRUCTURE OF BENZENE CONSUMPTION

[In percent of total]

	1959	1965	1970	1980	1980
Phenol (cumene)	18.6	49.5	42.7	33.9	27.6
Ethylbenzene	8.7	29.9	16.2	38.6	48.3
Caprolactam	(1)	(1)	11.0	16.0	14.1
Cyclohexane	(1)	4.3	3.0	1.6	0.9
Maleic anhydride/acid	(1)	3.0	1.0	0.5	1.0
Others	72.7	13.3	26.1	9.4	8.1

[1] Production negligible, if any.

Sources: N.P. Fedorenko, Ekonomika promyshlennosti sinteticheskikh materialov. Moscow: Ekonomicheskoy literatury, 1961, p. 163 for 1959. Chernyy, 1983, p. 188 for all other years.

Until the 1960's, coke-chemistry was nearly the sole source of benzene; in 1959, 99 percent of benzene came from coking, and only 1 percent from petroleum. This was because the USSR's first catalytic reformer was not inaugurated until 1958, at Ufa, and this was only an experimental unit; the first industrial unit did not start up until 1962, at Novokuybyshevsk.[21] Even by 1965, only 9 percent of benzene was derived from petroleum, and in 1970, 36.8 percent. But by the mid-1970's, catalytic reforming had become the major source of benzene, accounting for nearly 60 percent of output. Still, unlike many of the other organic chemicals, where petroleum raw materials predominate, a large share of benzene still comes from coke, 37.9 percent in 1980.[22]

Since the mid-1970's the share of benzene coming from catalytic reforming has diminished slightly due to the expansion of the pyrotol process, and in 1980, 17.3 percent of benzene was obtained as a byproduct of ethylene manufacture during pyrolysis.[23] The EP-450 unit at Nizhnekamsk is capable of producing 180,000 tons of benzene a year, the Kazan' unit, 160,000 tons, and the unit at Budennovsk, 100,000 tons. A similar unit, of 100,000 tons is approaching completion at the new Kalush olefin plant.[24] Unit 1986, all of the

[21] Sagers and Tretyakova, 1985, p. 19.
[22] Chernyy, 1983, p. 187.
[23] Chernyy, 1983, p. 187.
[24] Sagers and Shabad, 1986a.

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units employing this process were imported, but a domestically produced unit just was installed at Novo-Gor'kiy, operating off its EP-300. It has a capacity of 130,000 tons.

The major production center for the limited amount of petroleum-derived aromatics in the 1960's was Ufa, and it is probably still the largest, because of a recent expansion. A very large catalytic reforming unit was completed in 1983–1984, of French manufacture; it has a capacity for producing 125,000 tons of benzene, as well as 165,000 tons each of p-xylene and o-xylene.[25] An identical unit to the large benzene/xylene complex at Ufa was completed at Omsk, at about the same time (1983–1984). Like Ufa, Omsk also had some previously existing aromatics capability, and with the commissioning of these large new units, Ufa and Omsk are reportedly the largest centers of aromatic hydrocarbon production in the world. These two units are part of a complicated compensation deal with France, and some of the aromatics being exported (see above) represent product pay-back for the imported equipment.[26]

Two other large (120–125,000 ton) benzene units were completed recently, using Japanese equipment, one at Krasnodar in the late 1970's, and the other at Novopolotsk, in 1985. These are probably reformers and not pyrotol units.[27]

2. Xylenes

Xylenes production remained very small until the widespread use of catalytic reforming in the Soviet petroleum refining industry in the 1960's and 1970's (Table 3). Before that, xylenes were produced mainly from the distillation of hydrocarbon fractions in coal-tar. Even so, as early as 1963, 74.2 percent of xylenes were petroleum-based, and currently, 99 percent of xylenes are produced from petroleum, 98 percent from catalytic reforming alone.

The main uses for xylenes are in the production of resins (from phthalic anhydride), synthetic fibers, and as a solvent, although this varies somewhat among the three isomers: p-xylene (para-xylene), o-xylene (ortho-xylene), and m-xylene.

Para-xylene, the most important of the three, is used principally for the production of dimethyl terephthlalate and terephthalic acid (the intermediates for making polyester fibers). Production of p-xylene has grown extremely rapidly, increasing 50 times between 1960 and 1980,[28] with most of the growth occurring just since 1975, associated with the installation of several large units (see below). The first production of the p-xylene isomer in the USSR (at least from petroleum) occurred in 1959 at the Novokuybyshevsk oil refinery, which was even before its first catalytic reformer was installed (see above). The largest p-xylene plants in the USSR are the new units at Ufa and Omsk, which have capacities of 165,000 tons each (see above). Other major plants include Kirishi and Novopolotsk (Figure 1). Before the inauguration of the Ufa and Omsk units in 1984, Kirishi had the largest xylenes plant in the country. It was completed in 1976 using Japanese equipment and produces

[25] Theodore Shabad, "News Notes," Soviet Geography, Vol. 25 no. 7 (September 1984), p. 547.
[26] Jeanine D. Braithwaite, "Soviet Foreign Trade in Chemicals," Chapter 11 of a forthcoming book on the Soviet chemical industry, 1986.
[27] Sagers and Shabad, 1986a.
[28] Chernyy, 1983, p. 187.

both p-xylene and o-xylene. The capacity for each isomer is 60,000 tons per year. Novopolotsk's xylene plant was installed in 1970, and is of British manufacture. Initially it had a capacity of 44,000 tons per year, but is much greater now after being expanded in 1976.

Ortho-xylene is second in significance among the isomers. O-xylene output increased nearly 14 times between 1960 and 1980.[29] Its first production (from petroleum) was at the Novokuybyshevsk refinery in 1963. It is used mainly (as is m-xylene) to produce p-xylene through isomerization. Another important use is in the production of phthalic anhydride, the intermediate for alkyd resins manufacture. Through the mid-1960's, phthalic anhydride was produced almost entirely from naphthalene, from the coke-chemical industry, but the growing shortage of naphthalene led to the use of o-xylene for phthalic anhydride synthesis. Its production from o-xylene began on a significant scale in the mid-1960's at Angarsk, and several large units employing this process have been installed since.

The third isomer, m-xylene, is not used much directly in chemical synthesis. Its main use is as a high-octane gasoline component, although some m-xylene is utilized for isomerization to p-xylene and in the production of isophthalic acid.

D. METHANOL (METHYL ALCOHOL)

Methanol has become a large-volume basic chemical in the USSR, with a wide range of applications; a significant amount is exported (710,482 tons in 1985).[30] Production in 1985 was 2.850 million tons (Table 3), an increase of 50 percent since 1980, and over 2.8 times since 1970. This reflects a Soviet program to use utilize more comprehensively the country's large natural gas resources domestically and for exports.

Some 50 percent of all Soviet methanol is used for the manufacture of formaldehyde (for resins), 11 percent for isoprene synthetic rubber, and 9 percent for methylamine. A variety of other chemicals are derived from methanol, and it also is used in making photographic materials and as a paint and lacquer solvent. Unlike many of the other petrochemicals, methanol's consumption pattern has not changed a great deal in the last two decades. In 1965, 49.3 percent was used for formaldehyde, 10.4 percent for isoprene synthetic rubber, 5.2 percent for other chemical, uses, and 35.1 percent for nonchemical uses (e.g., export, gas industry); in 1959, 46.8 percent was used for formaldehyde and 18.7 percent for other chemical products.[31]

Production of methanol began in the early 1930's from the destructive distillation of wood, mostly to supply the formaldehyde needed for resins. But the increasing needs of the early Soviet plastics industry for formaldehyde triggered a change from wood to the "synthetic" production of methanol in the mid-1930's, using the catalytic reaction of carbon monoxide and hydrogen under pressure. The raw material used was water-gas or synthesis-gas, a mix-

[29] Chernyy, 1983, p. 187.
[30] Vneshnyaya Torgovlya SSSR v 1985 godu, p. 26.
[31] Sagers and Shabad, 1986a.

ture of carbon monoxide and hydrogen obtained from blowing steam over red-hot coke or coal. This process was first employed at Novomoskovsk, in Tula Oblast, in 1934. Several methanol plants of this type were constructed during the next two decades, and until the early 1960's, most methanol was derived from water-gas; in 1959, 99 percent of production was based on coal or coke.

However, a rapid transition to natural gas began in the 1960's, and it now represents the main raw material for methanol production. Although no methanol was produced from natural gas in 1959, by 1965, it accounted for 49 percent of production, and by the mid-1970's, 69.8 percent. Currently, the share of natural gas-based methanol is around 97 percent.[32]

The transition occurred as the older methanol plants converted to natural gas and several new plants were built. The whole range of chemicals produced at Novomoskovsk and Shchekino, in Tula Oblast, based on synthesis-gas, including methanol, began to be converted to natural gas in the 1950's, and methanol production at Severodonetsk, in the eastern Ukraine, associated with coke-based ammonia synthesis, also converted to natural gas. Severodonetsk is now a large producing center, particularly of methanol for export. Several new plants were built along natural gas pipelines in the 1960's and 1970's, generally in conjunction with ammonia synthesis; these include Jonava, in Lithuania, and Novgorod, where production began in the late 1960's, and Nevinnomyssk, which acquired a methanol unit in 1976 (Figure 1).

The USSR's principal methanol plants, though, are very recent additions. Both use British equipment, and have production capacities of 750,000 tons per year, making them the largest in the world. The first of these, at Tomsk, yielded its first product in 1983, and reached design capacity in early 1984. The second plant, at Gubakha in Perm' Oblast, came on line in 1984 and reached production capacity a year later. Each plant now reportedly produces nearly a third of Soviet methanol output. Like the aromatics, both of these large plants are part of compensation deals in which part of the output is exported to pay for the equipment.[33]

V. 12th Five-Year Plan: Targets and Prospects for Fulfillment

Expanding production of these key primary petrochemicals is to continue at a fairly rapid rate, largely driven by the increasing demand for modern plastics and fibers. During the 12th Five-Year Plan (1986–1990), the production of chemical fibers is to increase by nearly 33 percent, while plastics output is to increase by about 40 percent.[34] To support this expansion, benzene output is to increase by 50 percent, and that of ethylene and propylene by 40 percent.[35] No information is available on what is planned for xylenes or methanol output, but it would probably be in this same range, although in both cases, a surprisingly large proportion of output is

[32] Sagers and Shabad, 1986a.
[33] Braithwaite, 1986.
[34] Pravda, June 19, 1986; Sotsialiticheskaya Industriya, March 9, 1986.
[35] N.B. Lemayev, "Zadachi nauchno-tekhnicheskogo progressa v. neftepererabatyvayuschchey i neftekhimicheskoy promyshlennosti i mesto v ikh reshenii kataliza tseolitakh," Neftekhimiya, no. 2 (1986), pp. 147–150; reference on p. 147.

exported: 35 percent of xylenes and 25 percent of methanol (see above). For benzene, the growth target implies an increment in production of about 1 million or so, equivalent to 6–8 new production units, and for ethylene and propylene, the planned increment is also about 1 million tons, representing 3–4 new production units.

A. EQUIPMENT AVAILABILITY

One problem which may prevent the fulfillment of these targets is a shortage of equipment. The Soviet chemical engineering industry has long had serious shortcomings,[36] and does not seem capable of delivering this much equipment, particularly for the aromatics. The sector had been a high priority for expansion earlier because of the chemicalization drive launched under Khrushchev, and therefore had been one of the most dynamic of the individual machine-building sectors in the 1960's. Even at that time it was not equal to the challenge, however, and large amounts of chemical equipment had to be imported to support the chemicalization drive.[37] Since 1970, the priority of the sector (in terms of investment share) has been declining.

Furthermore, since the 1970's, the USSR's mounting energy problems have led to a heightened emphasis on the oil and gas sectors,[38] resulting in a high rate of growth in the production of oilfield and drilling equipment, and since it is produced in the same ministry as chemical equipment (Ministry of Chemical and Petroleum Machine-Building), resources undoubtedly have been shifted into oil and gas equipment from chemical machine-building. For example, one of the leading producers of chemical equipment, the "Frunze" plant in Sumy, became embroiled in the high priority crash program to supply compressors for gas pipelines in the early 1980's,[39] and now it has been designated to produce gas-lift equipment for the oil industry, seen as the key to improving performance in the crucial West Siberian fields.[40]

Weaknesses in the domestic chemical machine-building industry were the principal reason for such a large proportion of the petrochemical industry's new production capacity in the 1970's being comprised of imported equipment. The imported Western ethylene equipment installed at Novopolotsk, Kazan', Nizhnekamsk, and Budennovsk (see above) comprised about 18 percent of total installed ethylene capacity in the USSR in 1985,[41] and may have produced

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[36] Ronald Amann, "The Chemical Industry: Its Level of Modernity and Technological Sophistication," in Ronald Amann, Julian Cooper and R.W. Davies (eds.), *The Technological Level of Soviet Industry*. New Haven and London: Yale University Press. 1977, pp. 227–327.

[37] Amann, 1977.

[38] Thane Gustafson, "The Origins of the Soviet Oil Crisis: 1970–1975," Soviet Economy, Vol. 1 no. 2 (April–June, 1985), pp. 103–135; Ed A. Hewett, Energy, Economics, and Foreign Policy in the Soviet Union. Washington, D.C.: Brookings Institution, 1984. Thane Gustafson, "Soviet Adaptation to Technological Pressures: The Case of the Oil and Gas Sector, 1975–85," in Philip Joseph (ed.), Adaptability to New Technologies of the USSR and East European Countries. Brussels: NATO Colloquium, April, 1985, pp. 151–197.

[39] Thane Gustafson, "The Soviet Response to the American Embargo of 1981–1982: The Case of Compressors for the Export Gas Pipeline," in Gordon B. Smith (ed.), The Politics of East-West Trade. Boulder, Colo.: Westview Press, 1984, pp. 129–141.

[40] Matthew J. Sagers, "Recent Developments in the Soviet Oil, Coal, and Electric Power Industries," PlanEcon Long-Term Energy Outlook, Fall, 1986b.

[41] Sagers and Shabad, 1986a.

as much as 30 percent of all Soviet ethylene in the mid-1980's, and a similar share of propylene.[42] The Western benzene units operating at Nizhnekamsk, Budennovsk, Kazan', Ufa, Omsk, Krasnodar, and Novopolotsk account for around 48 percent of Soviet benzene production, and the production of xylenes is even more dependent upon Western equipment; the units installed at Novopolotsk, Kirishi, Ufa, and Omsk produce over 90 percent of all Soviet xylenes. The two big imported Western methanol units at Tomsk and Gubakha alone produce nearly two-thirds of Soviet output.

These high shares of output indicate the industry's considerable dependence upon imported equipment, symptomatic of several other sectors of the chemical industry. Therefore, since there is apparently no provision for imported equipment in the 12th Five-Year Plan (no new equipment contracts have been signed), it is uncertain if sufficient domestic equipment supplies can be obtained. This then could lead to insufficient basic petrochemicals to support the expansion of synthetic materials and in turn, jeopardize the industrial modernization programs in machine-building and construction.

However, it does appear that the goal for olefins is within reach, as two plants have been under construction for some time, at Novokuybyshevsk and Sumgait, and should be commissioned soon, while construction has already begun on a new unit at Tomsk.[43] These are all domestic EP-300s, and it appears that at least these units can be manufactured in sufficient quantities. But it is difficult to envision much new capacity for benzene, xylenes, and methanol without equipment imports from the West.

B. FEEDSTOCK AVAILABILITY

Another possible constraint in expanding petrochemical production is feedstock shortages. Although primary petrochemical production is to expand by some 40–50 percent, petrochemical feedstocks as a whole are to increase by only 20 percent between 1985 and 1990.[44] This is but one example of the overall emphasis in the Plan on raw material savings and greater efficiency in their use. The problem is that the exact source of these savings in feedstocks is not clear. In fact, feedstock shortages are already a problem for many petrochemical plants, and prospects are for the situation to become worse.

For example, in the key Volga-Urals region, less NGL is available from gas plants in the region for petrochemical synthesis because of the sharp decline in petroleum production, and therefore associated gas output, in the Volga-Urals region in the last decade. The same problem also has occurred in the North Caucasus. A new NGL pipeline from West Siberia to the Volga-Urals ws completed in 1985, which should help ease feedstocks problems there, and at Budennovsk, low-octane gasoline from the Groznyy refineries has had to replace local NGL feedstocks.

A serious feedstock shortage also is known to plague the Shevchenko plastics plant in Kazakhstan, one of the largest in the coun-

[42] Sagers and Shabad, 1986a.
[43] Sagers and Shabad, 1986a.
[44] Lemayev, 1986, p. 147.

try. The nearby Kazakh gas plant has been unable to supply enough ethane for ethylene manufacture because of the decline in local oil and associated gas output, so styrene has to be brought in to run the plant.[45] The petrochemical operation at the nearby Gur'yev oil refinery, which is based on refinery gases, also has been suffering because supplies of local crude have not been available to maintain refinery throughout.[46]

Like Gur'yev, many of the older Soviet petrochemical plants utilize refinery gases for feedstocks. This includes plants such as Novokuybyshevsk, Salavat, Ufa, and Novopolotsk. Thus as refinery throughout fell in 1985 throughout the USSR due to the shortage of crude,[47] petrochemical production at these key plants probably was adversely affected. Although crude production has bounced back in 1986,[48] future output trends are highly uncertain. If Soviet crude petroleum production should decline significantly by 1990, leading to reduced refinery throughout, the availability of refinery gases for feedstocks could again be adversely affected. Also, naphtha supplies for pyrolysis and reforming will be affected by the overall availability of crude (which has become increasingly tight), as well as trends in the refinery sector for producing more light products per ton of crude refined (see above).

One potential source of feedstock savings lies in shifting the feedstock mix to lighter products because they yield more ethylene and other primary products, particularly given the considerable increase in Soviet NGL production in recent years.[49] Typically, the yield of desired products from ethane is about 80 percent, from LPG, 60–65 percent, from naphtha, 50–55 percent, and from gas-oil, 40–45 percent.

Most of the USSR's pyrolysis feedstocks are comprised of relatively heavy refinery liquids (naphtha and gas-oil). These accounted for about three-quarters of the total in 1980 (Table 1). Although some shift to the lighter feedstocks can be discerned, such as from gas-oil to naphtha and LPG to ethane (Table 1), this has been too limited to significantly increase yields and reduce overall feedstock needs.

Interestingly, the lighter products previously dominated petrochemical feedstock supplies, as the current predominance of naptha is fairly recent. Before the 1970's, when olefin production was small, the major feedstocks were NGL (LPG and ethane) and refinery gases. In 1960, they accounted for 79 percent, and in 1965, 78 percent, of feedstocks (Table 1). As late as 1970, naphtha comprised only 20 percent of all ethylene feedstocks. But as olefin production began to reach significant levels in the 1970's, naphtha came to dominate the feedstock pattern.

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[45] Theodore Shabad, "News Notes," Soviet Geography, Vol. 21 no. 3 (March, 1980), pp. 190–191; Vol. 24 no. 5 (May, 1983), p. 404.

[46] Sagers and Shabad, 1986a.

[47] "Soviet Union Starts Campaign To Upgrade Refineries," The Oil and Gas Journal, March 3, 1986, p. 26.

[48] "Significant Upturn in Soviet Oil and Coal Production Spells the Possibility of a Flood of Soviet Oil on the World Market in the Second Half of 1986," PlanEcon Report, Vol. 2 Nos. 29–30 (July 24, 1986).

[49] Matthew J. Sagers, Natural Gas Liquids and the Soviet Gas Processing Industry, CIR Staff Paper No. 14. Washington, D.C.: Center for International Research, Bureau of the Census, 1986a.

This is just opposite global trends. During this same period, the world petrochemical industry has been rapidly switching from liquid to gaseous feedstocks. This is because the dramatic oil price increases in 1973 and 1979 affected chiefly the liquid oil products and made them relatively more expensive than gaseous hydrocarbons.[50] This change in feedstock base has resulted in a global redistribution of the petrochemical industry towards raw material locations. Whereas the oil-based feedstocks were available at refineries located in consuming areas, the gaseous feedstocks are available only at the source of raw materials (gas and oil fields). Thus, globally the industry has been shifting from its traditional locations in North America and Western Europe to the Middle East and other major gas producers (e.g., Saudi Arabia, Kuwait, Mexico, Indonesia).[51] Similarly, production has shifted *within* North America and Western Europe to raw materials (NGL) sites, such as Alberta, in western Canada, and Mossmorran, in Scotland.[52]

One reason for the USSR's increasing reliance on refined petroleum liquids is the relative underdevelopment of the gas processing industry in the USSR, with little of the available light hydrocarbons actually being extracted.[53] Another key problem in utilizing NGL in the Soviet petrochemical industry is its regional availability. This is because, in contrast to global trends, the Soviet petrochemical industry has remained concentrated in the Volga-Urals region, where it developed in the 1950's and 1960's, closely tied to refinery-based hydrocarbons, although local production from associated gas traditionally supplied a significant amount of NGL.[54] But hydrocarbon production has declined sharply in the Volga-Urals region since the 1970's, and this has greatly reduced the supply of local raw materials for feedstock use. In contrast, hydrocarbon production in West Siberia has soared. By 1985, West Siberia supplied 62 percent of Soviet oil and 58 percent of gas, while the Volga-Urals contributed 8 percent of gas (now largely high-sulfur Orenburg gas) and 23 percent of oil.[55] This compares with 1970, when the Volga-Urals produced 59 percent of Soviet oil and 9 percent of gas (which was then mostly associated gas). Thus, West Siberia is producing an increasing share of Soviet hydrocarbons and NGL, while there is a growing shortage for petrochemical use in the Volga-Urals region.

It was to partially rectify this problem that the 11th Five-Year Plan (1981–1985) included the construction of a NGL pipeline from West Siberia to the Volga-Urals. The pipeline, which was finished in 1985, carries natural gasoline from the gas plants in the West

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[50] OECD (Organization for Economic Cooperation and Development), Petrochemical Industry: Energy Aspects of Structural Change. Paris: DECD, 1985.

[51] J.T. Quant, London: Distribution of Petrochemicals Towards the 1990's: A View of a Producer. Shell Chemicals, 1981; United Nations, First World-Wide Study on the Petrochemical Industry: 1975–2000. New York: Internal Center for Industrial Studies.

[52] Keith Chapman, "Control of Resources and the Recent Development of the Petrochemical Industry in Alberta," The Canadian Geographer, Vol. 29 no. 4 (Fall, 1985), pp. 310–326; "Further Shakeout Expected in Europe's Ethylene Industry," Chemical and Engineering News, November 25, 1985, pp. 15–17.

[53] Sagers, 1986a.

[54] Sagers and Shabad, 1986a.

[55] Theodore Shabad, "News Notes," Soviet Geography, Vol. 27 no. 4 (April, 1986), pp. 248–265.

Siberian oil fields processing associated gas as well as stable gas condensate from the Urengoy gas field.[56]

Thus, in the USSR, the trend has been one of moving NGL to established petrochemical centers rather than shifting the industry to the new raw material sites. Although the Soviet petrochemical industry has been very slow in making the spatial shift to take advantage of the new feedstock materials, West Siberia has experienced some petrochemical development. Omsk has become a major petrochemical center (Figure 1), although it is largely organized around its huge oil refinery. But two other large West Siberian NGL-based petrochemical complexes, after lagging for many years, are now coming on line, although they are still not fulfilling initial Soviet expectations for the projects.

One of these is at Tobol'sk, where its first unit, a 3 million ton gas fractionator, began operations in 1984. Once envisaged as the USSR's largest synthetic rubber complex, its significance has become doubtful in recent years.[57] It produces individual paraffin hydrocarbons from NGL, supplied by the West Siberia—Volga-Urals NGL pipeline.[58] These were to be used for the production of synthetic rubber monomers (butadiene, isoprene), but these downstream production units still do not exist, so the feedstocks are shipped out to synthetic rubber plants in the European USSR. Plans also call for the eventual installation of an olefin plant. The other new petrochemical plant is at Tomsk. Its huge methanol and polypropylene units, installed in the early 1980's, are operating, but it does not yet have its own olefin production, and the propylene monomer is railed in for polymerization. A large 300,000 ton ethylene unit, to be based on NGL, is under construction, and is scheduled to produce its first output in 1987.

[56] Sagers, 1986a, pp. 43–44.
[57] Sagers and Shabad, 1986b.
[58] Sagers, 1986a, p. 41.

THE SOVIET CHEMICAL INDUSTRY: CHEMICALIZATION, CAPITAL, AND COMPENSATION

By Jeanine D. Braithwaite*

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SUMMARY

The purpose of this article is to assess the Soviet chemical industry and to evaluate its potential for achieving the targets contained in the 12th Five Year Plan (1986–1990) and the Chemicalization Program. It seems unlikely that these performance targets will be fulfilled, due to the persistence of input supply bottlenecks and the dependency of the industry upon imported technology.

This article examines the key area of efficiency of factor utilization, primarily focusing on capital, the most important factor in chemical technology. The Soviet Union has experienced major problems with capital utilization in the chemical industry, due to input shortages, inadequate infrastructure and problems with the assimilation of new technology. Estimates of Soviet dependency on foreign equipment for several chemical products are provided.

In the first section, the new plan targets are delineated, the Chemicalization Program is discussed, and output trends for key products are presented. Second, the crucial area of factor utilization is analyzed, with plan targets examined in light of historic trends in capital-output ratios, degree of capacity utilization, and problems of assimilating new technology. In the third section, the industry's foreign trade performance is analyzed and the impact of the new plans on Soviet chemical exports is discussed. The fourth section concludes the paper and presents prospects for the Soviet chemical industry.

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I. Soviet Chemicalization Program and Output Trends

The Soviet chemical industry[1] was targeted as a growth sector and special contributor to the acceleration of scientific and technical progress during the 27th Party Congress as evidenced by the adoption of the "Comprehensive Program for the Chemicalization of the National Economy of the USSR for the period ending in the year 2000." [2] This is not the first Soviet chemicalization program (Khrushchev introduced the first in 1958), but it does mark a renewed interest in the chemical industry since the sharp curtailment of imports of foreign equipment in the late 1970's and the noticeable reduction in investment priority in the early 1980's. The recent concern with the chemical industry is due to disappointment with the "systemic lag" in its performance and the recognition that shortfalls in chemical production pose an acute problem not only for the chemical industry *per se*, but also for the modernization of the economy as a whole, because of forward linkages with heavy industry, especially machine-building and construction, and with agriculture. By the term "chemicalization" the Soviets mean increasing both the output of chemical products and their consumption by industrial branches and Soviet consumers. The three major tasks of the Chemicalization Program are to meet the requirements of the economy, to accelerate the development of the branch, and to improve the utilization of chemical products.

The primary goal of the Chemicalization Program is to increase output, which fell short by 2 billion rubles in 1985.[3] Output trends and targets are presented in Table 1. The other major programs of the 27th Party Congress require specific types of advanced chemical products; notably plastics manufactures for machine-building, highly refined products for microelectronics and optics, and multinutrient fertilizers and advanced pesticides for agriculture. The requirements of the national economy for chemicals as embodied in the 12th Five Year Plan (FYP) call for chemical and petrochemical output to increase to 130–132 percent of the 1985 level by 1990, while output in the year 2000 is to be 1.8–1.9 times the 1990 level. The implied average annual growth rate for the chemical industry during the 12th FYP is 5.4–5.7 percent, which exceeds the official average growth rate of 4.9 percent per annum achieved in the 11th FYP (1981–1985) and greatly exceeds the Western estimated average annual growth rate of 4.3 percent for this period.[4] The planned average annual growth rate for the period 1990–2000 is an ambitious 6.1–6.6 percent, remniscent of the early 1970's, an atypical period when chemical output soared due to the assimilation of new

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[1] The Soviet chemical industry includes basic chemicals, mineral chemicals, plastics, synthetic fibers, paints and dyes, pharmaceuticals, organic chemicals, tires and rubber-asbestos products. This designation corresponds to the term "the chemical and petrochemical industry" in Soviet handbooks.

[2] Kompleksnaya programma khimizatsii narodnogo khozyaystva SSSR na period do 2000 goda. Moscow: Politizdat, 1985.

[3] Pravda. June 19, 1986, pp. 1–5. Hereafter, Ryzhkov speech, June 18, 1986.

[4] Soviet official growth series are believed to overstate real output growth, and Western analysts have recalculated these series to correct for this problem. See USSR: Measures of Economic Growth and Development, 1950–80. Washington: U.S. Government Printing Office, 1982, for methodology. Official series data calculated from Narodnoye khozyaystvo SSSR v 1985 g., Moscow: Finansy i statistiki, 1986, p. 144 (hereafter, Narkhoz 19xx) and Western estimates from *Handbook of Economic Statistics, 1986*, Washington: U.S. Government Printing Office, 1986, p. 71 (hereafter, Handbook, 1986).

capacity from imported equipment. Additionally, the growth rate of key sectors is planned to exceed this average: plastics production, for example, is to increase by 36–42 percent (Table 1). Unlike the early 1970's though, growth in the 1980's and 1990's is to be based primarily on domestically produced equipment because excessive reliance on imported technology has been recently emphasized as a problem for the Soviet economy.[5]

TABLE 1.—OUTPUT TRENDS AND 12TH FYP GOALS FOR THE CHEMICAL INDUSTRY

[1,000 tons]

Year	Mineral fertilizers	Pesticides	Plastics and resins	Chemical fibers	Synthetic rubber
1960	3,281	32	312	211	380
1965	7,389	103	803	407	670
1970	13,099	164	1,670	623	1,030
1975	21,998	264	2,838	955	1,670
1980	24,767	285	3,637	1,176	2,050
1981	25,998	299	4,089	1,213	n.d.
1982	26,738	316	4,058	1,235	n.d.
1983	29,733	332	4,419	1,353	n.d.
1984	30,808	343	4,819	1,401	n.d.
1985	33,194	348	5,019	1,394	2,200
1990	41,000–43,000	440–480	6,800–7,100	1,850	2,700–2,900

Sources: *Narkhoz*, various years. 1990 12th FYP targets as reported in *Ekon. gazeta*, No. 12, March, 1986, p. 10. Synthetic rubber series from Sagers and Shabad, 1986, Chapter 7.

Notes: Mineral fertilizers in 1000 tons of nutrient content, and pesticides in 1000 tons of active ingredients.
n.d. no data.

The second task of the Chemicalization Program is the acceleration of the development of the chemical industry through increased capital formation and labor productivity, in order to achieve the ambitious output growth targets. One of the "most crucial" sections of the 12th FYP is the enormous capital construction program, totaling 994 billion rubles. Eighty percent of the total increase in investment is to be concentrated on the key programs; the Food, Energy, Machine-building, Electronics and Chemicalization Programs. Investment is the chemical industry alone is to increase by a factor of 1.5 during the 12th FYP. The chemical industry accounted for approximately 4 percent of industrial investment in 1950, but this share increased during the 1960's to about 9 percent in the 9th FYP (1966–1970) as chemicals became a higher priority under Khrushchev and Brezhnev. In the 1970's, investment in the chemical industry was about 9–10 percent of all industrial investment, but this share fell to 7.5 percent in the 11th FYP (1981–1985).[6]

Although the principal thrust of the Chemicalization Program is for increased output, the third goal is the more efficient utilization of chemical products througout the economy. First, chemical pro-

[5] For example, see Ekonomicheskaya gazeta, Number 11, March 1986, pp. 23-30, Ed A. Hewett, "Gorbachev's Economic Strategy: A Preliminary Assessment," Soviet Economy, Volume 1, Number 4, (October-December), 1985 and Ekonomicheskaya gazeta, No. 21, May 1986, p. 21. For Soviet accounts of the recent development of the chemical industry, see L.A. Kostandov *et al.*, Razvitiye khimicheskoy promyshlennosti v SSSR 1917-1980, Moscow: Khimiya, 1984, and V.V. Listov, Khimicheskaya promyshlennost' v odinnadtsatoy pyatiletke, Moscow: Khimiya, 1984.

[6] Data from Narkhoz, various years. Data for 1950 is based on 1962 prices, data for 1960 is in 1969 prices, and data for the rest of the years is in 1973 prices.

duction is to become less wasteful due to increases in recycling and improvements in the utilization of raw materials. Second, the effectiveness of using chemicals is to be raised by comprehensive application (using more than one chemcial product at a time), by the rational combination of chemical products with traditional materials, and by widening the consumption of chemicals in various branches of the economy. Increased consumption of plastics by the machine-building and metal working (MBMW) sector has been a nominal goal for the chemical industry for several years, but the extreme expectations for MBMW performance outlined at the 27th Party Congress mandate greatly increased deliveries of plastics and plastic parts to MBMW. In 1983, MBMW and construction accounted for 26.3 and 12.1 percent of plastics consumption respectively.[7] Utilization of chemicals is to improve not only in the "productive" sphere of the economy, but in domestic consumption as well. The Chemicalization Program includes the goal of raising consumption of consumer products which require chemical inputs, such as synthetic fibers, artifical leather, dyes, mordants, plastics, and paints and lacquers. The light and food industries consumed 13.7 percent of plastics output and 77.1 percent of chemical fiber output in 1983.[8]

II. Efficiency of Factor Utilization

The ability of the chemical industry to fulfill the ambitious targets described above (Table 1) depends on the allocation of factors to the chemical industry and the efficiency with which they are employed. The most important factor for any modern chemical industry is capital, since optimal chemical technology is highly capital-intensive. At first glance, traditional Soviet investment strategy would seem to be well-suited for meeting this requirement of the chemical industry; whatever the shortcomings of the traditional command economy system, one of its significant attributes is the ability to mobilize tremendous capital resources and to focus those resources on a few key sectors. For example, in the production of petrochemicals and the advanced chemical products which use petrochemical inputs (plastics, synthetic fibers, synthetic rubber), increasing the scale of the plant often leads to cost reductions and improvements in output quality.[9] As the data in Table 2 indicate, investment resources have been concentrated on the chemical industry.

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[7] Listov, 1984, p. 14.

[8] Listov, 1984, p. 14 and 18.

[9] The Soviets have had some success with increasing the scale of chemical production, notably with "Polymer-60", a unit for low-density polyethylene, and with ammonia. The savings from increasing the scale of production are mentioned frequently in the literature; for a comparison see *Zhurnal vsesoyuznogo khimicheskogo obshchestva imeni D.M. Mendeleveva*, No. 1, 1972, pp. 25–28, (hereafter, *Zh. Mendeleveva*) and *Zh. Mendeleveva*, No. 2, 1977, pp. 167–171.

TABLE 2.—INVESTMENT IN THE CHEMICAL INDUSTRY

Period	Million rubles—		Chemical industry share (percent)
	Chemical industry	Industry total	
1966–70	10,993	122,494	8.97
1971–75	15,616	172,500	9.05
1976–80	22,158	224,000	9.89
1981–85	22,600	300,700	7.52
Year:			
1981	3,800	49,500	7.68
1982	4,000	50,900	7.86
1983	4,100	53,700	7.64
1984	4,800	61,900	7.75
1985	4,500	65,500	6.87

Note.—Data from "Narkhoz," various issues. Due to a change in reporting this series, the years preceding 1984 are in constant 1973 prices while 1984, 1985 and the period 1981–1985 figures are in constant 1984 prices. A comparison of overlapping years shows a negligible effect of changing base upon the share estimates presented in the final column of the table.

TABLE 3.—IMPORTS OF CHEMICAL EQUIPMENT

Year	Chemical equipment imports (million FTR)	Percent share of chemical equipment imports out of—		Net chemical equipment imports (million FTR)
		All equipment imports	Total import bill	
1960	167.0	11.08	3.30	161.9
1965	187.4	7.73	2.58	182.6
1970	218.0	5.81	2.06	164.8
1975	638.0	7.05	2.39	558.6
1976	1,132.4	10.86	3.94	1,046.4
1977	1,722.3	15.02	5.72	1,618.0
1978	1,743.5	12.00	5.05	1,649.5
1979	1,753.6	12.18	4.63	1,656.4
1980	1,243.9	8.26	2.80	1,154.4
1981	825.5	5.47	1.57	739.8
1982	852.6	4.40	1.51	777.5
1983	1,042.5	4.58	1.75	955.1
1984	1,176.3	4.91	1.80	1,068.2
1985	1,042.5	4.06	1.51	944.0

Note.—Net chemical equipment imports are imports less exports. Chemical equipment imports and net imports are in million foreign trade rubles (FTR) and correspond to foreign trade nomenclature code 150, and thus exclude pumps and compressors (code 155).

Source: "Vnesfinaya torgovlya SSSR," various years.

TABLE 4.—*Share of chemical output produced on machinery imported from the West: 1985*

Chemical product	*Share (percent)*
Nitrogenous fertilizers (all)	65
Ammonia	70
Urea	74
Multinutrient fertilizers	[1] 75
Synthetic fibers:	
"Nitron" (Orlon)	90
"Lavsan" (Dacron)	90
"Kapron" (Nylon 6)	[2] 75
Plastics:	
Polyethylene	94
Polypropylene	85–90

Chemical product	*Share (percent)*
Polystyrene	60–65
Polyvinyl chloride	50
Cellulose acetate	(3)

[1] For 1980, see note 29.

[2] Not all imported equipment used in "kapron" production is from the West. Synthetic fibers are listed by their Soviet name, followed by their American equivalent in parentheses. For estimates of the share of primary petrochemicals produced on imported equipment, see Sagers, this volume.

[3] More than half.

Source: Sagers and Shabad, 1986, 12.

The increase in the chemical industry's investment share has been paralleled by an increase in the share of imported equipment. As the data in Table 3 indicate, the share of imported equipment allocated to the chemical industry has fluctuated over the period 1970–1985, reaching a peak of 15 percent in 1977. Access to imported technology was then cut back abruptly in the early 1980's, with the share falling to 4 percent in 1985.

The effect of this investment wave in foreign equipment is detailed in Table 4, which provides estimates of the share of Soviet chemical output produced by imported equipment for several important chemical products. As is evident, Soviet dependency on imported technology is extremely high for the advanced chemical products (synthetic fibers and plastics). It appears that investment resources channeled to the Soviet chemical industry since 1960 have been concentrated on foreign technology.

A. CAPITAL-OUTPUT RATIOS

In spite of significant investment expenditure, the USSR has experienced a number of difficulties in commissioning new capacity, assimilating new technology, upgrading existing facilities, expanding research and development (R&D), and meeting production plans in the chemical industry. These difficulties are reflected in rising capital-output ratios in the chemical industry.[10] The rising trend in capital-output ratios and the persistence of these problems in the chemical industy make the attainment of the ambitious FYP goals problematic. Capital-output ratios are presented in Table 5 in two variants; ratios calculated on the basis of official Soviet data, and ratios based on Western estimates. Official Soviet output series are known to seriously overstate real growth, due to methodological problems in their construction. Western estimates attempt to remove this bias, and show a rising trend for capital-output ratios over the entire period 1970-1985, with especially sharp increases in the mid-1970's and early 1980's. Even official Soviet data reflect a downturn in performance in the 1980's, although the problems in the 1970's are not reflected by the Soviet series. Apparently performance in the 1980's had so deteriorated that even inflation in the Soviet output series could not compensate, and so official capital output ratios declined.[11] The sharp increase in capital-output

[10] The Soviet economy as a whole is experiencing rising capital-output ratios, which is one facet of the overall growth slowdown that is examined elsewhere in this volume. This "negative trend in indicators" was severely criticized by Ryzhkov at the Party Congress while the chemical industry was singled out for a recitation of deficiencies and for increased investment, since it is a sector which effects overall economic progress (Ryzhkov speech, June 18, 1986).

[11] And additional reason may be the price change of 1982, which may have eliminated some of the new product bias in the output series. Using an official series based in 1984 prices with base year 1980 may reduce the scope for the new product bias and index number problems.

ratios in the mid 1970's is not surprising since several large plants, based on imported equipment, were under construction during that time. However, the increase in capital-output ratios in the 1980's was not due to new construction, but was caused by problems detailed below.

TABLE 5.—CAPITAL-OUTPUT RATIOS FOR THE CHEMICAL INDUSTRY

[1970 base year]

Year	Western series	Soviet series
1970	100.00	100.00
1971	102.28	103.93
1972	104.21	104.80
1973	103.21	102.38
1974	104.72	101.28
1975	105.00	100.47
1976	109.31	101.48
1977	112.53	103.49
1978	114.22	104.61
1979	125.09	110.46
1980	134.73	117.47
1981	142.25	121.21
1982	149.28	127.31
1983	151.28	129.60
1984	155.16	130.61
1985	156.04	133.54

Note.—Soviet series are based on data from "Narkhoz," various issues. Western series are based on data from "USSR: Measures," 1982 and "Handbook," 1986 (see note 4).

Rising capital-output ratios can indicate problems in resource allocation, such as increasing only one factor of production, or accumulating capital without significant technical progress. Generally, rising capital-output ratios are a cause for concern.[12] Simple production theory indicates that even with constant returns to scale, increasing one factor leads to decreasing returns for that particular factor in the absence of commensurate increases in other factors, such as labor or raw materials. As detailed below, many Soviet chemical plants have experienced bottlenecks in input supply, and there is some indication that shortages of skilled labor are also becoming a problem. A resource allocation problem can also arise when the wrong kind of factor is used, for example if outdated or inferior equipment was installed. The reliance on foreign technology for the development of the Soviet chemical industry indicates that planners tried to avoid choosing outdated capital, but excessive lead-times sometimes rendered technology dated before full capacity was even achieved.

1. Degree of Capacity Utilization

The systemic influences which cause bottlenecks to be a persistent "dysfunction" in the Soviet economy are well known, and naturally the chemical industry has not been able to avoid them. The

[12] Some capital deepening can be expected as an industry matures, and thus a slight upward trend in capital-output ratios would not be surprising, although improved capital and labor productivity would offset such a trend. However, the steep increases in capital-output ratios in the mid-1970's and during the 1980's cannot be fully explained by capital deepening; rather they indicate the existence of significant problems, which are corroborated in the literature.

three major bottlenecks which plague the industry are input supply shortfalls, inadequate infrastructure, and power supply fluctuations. Due to the system of taut planning and the diffusion of authority across ministerial lines for new projects, some chemical plants have come on-stream with inadequate input supplies because supporting plants have not been commissioned. Input supply bottlenecks are a problem to a greater or lesser degree for all chemical plants, from small paint plants to large chemical combines, but are especially striking when they occur at high priority plants such as Tomsk, which failed to meet its production plans for polypropylene and methanol in 1982 and 1983.[13] The large increases in the production of plastics and fibers envisioned in the 12th FYP (Table 1) cannot be achieved without the necessary petrochemical intermediates, yet the prospects for increases in petrochemical production without new equipment imports are dubious at best.[14] Thus, a worsening of input supply bottlenecks during the 12th FYP for both the petrochemical and chemical industries is likely.

Overall, capacity in the chemical industry has been underutilized, partially due to interruptions in input supply. Some of the supply problems are due to the rapid expansion of the chemical industry in the 1970's; major claimants such as Tomsk were built without sufficient support. The "lack of planning" that results in such "disproportions" has been repeatedly excoriated by top Soviet officials, most recently at the 27th Party Congress, when complaints about the underutilization of capacity and the resultant reliance on chemical imports were aired.

Inadequate infrastructure, particularly a lack of rail transport and specialized storage facilities, is one of the major "disproportions" that has characterized the development of the Soviet chemical industry. This is a perennial problem with the distribution of fertilizers, and not even the creation of 1980 of a separate ministry solely for fertilizer production has alleviated the problem.[15]

Power supply fluctuations are the third serious bottleneck plaguing the Soviet chemical industry. Power supply fluctuations are particularly devastating for continuous process technology, because they cause significant losses of raw materials. Although chemical plants are supposed to be guaranteed a steady base-load power supply, in actuality fluctuations range from 5 to 30 percent.[16]

2. Problems of Assimilating New Technology

One of the benign causes for a temporary increase in capital-output ratios is the need for a certain amount of lead-time required to bring plants up to full capacity. However, cost overruns in construction and prolonged lead-times can extend this "temporary" problem for several years, which can no longer be described as benign. Additionally, if there are continued problems in assimila-

[13] The press is full of articles about input supply problems. For some examples, see *Izvestiya*, January 5, 1986, p. 2 (Tomsk), *Pravda*, November 1, 1982, p. 3 (Shevchenko), *Pravda*, March 16, 1983, p. 2 and March 23, 1983, p. 2 (Sokal'sk).

[14] See Sagers, this volume.

[15] For some examples, see *Pravda*, August 11, 1982, p. 2 and March 1, 1983, p. 1, *Izvestiya*, April 12, 1985, p. 3 and *Sotsialisticheskaya industriya*, May 23, 1982, p. 2.

[16] *Izvestiya*, May 18, 1982, p. 18.

tion, the plants may never reach rated capacity while capital repair costs mount.

The Soviet economy in general has been plagued with excessive cost overruns and long lead-times in bringing projects to full capacity production. The most obvious cause of long lead-times is the slow pace of Soviet construction, and measures to improve construction were discussed extensively at the 27th Party Congress. The problem has become so acute that Ryzhkov announced the scrapping of some projects with obsolete technology due to protracted construction delays. Such construction delays are probably the most significant problem facing the Soviet chemical industry today.

Protracted delays have always been a problem for the chemical industry, but this problem has worsened in the 1980's. In 1965 a survey found that construction norms were routinely exceeded by 50 to 75 percent, and it was estimated that completion of chemical plant construction was 2 to 5 years behind schedule during the 1970's.[17] In 1979, a survey of British chemical equipment exporters found that the "excess" lead-time in the USSR, aside from the negotiation phase, was two and a half to three years.[18] In the 1980's, chemical project lead-times were typically reported in the Soviet press at about six to seven years.[19] The volume of unfinished construction work in the chemical industry peaked at 9,188 million rubles in 1978, but has remained high in the 1980's, ending at 5,474 million rubles in 1984.[20]

The obsolescence of technology due to excessively long lead-times is a special problem for the chemical industry, since chemical technology changes very rapidly. Virtually every chemical plant constructed in the USSR since the early 1970's has experienced delays due to design changes. In several cases, projects have been close to completion, but technological advances have rendered them obsolete before start-up. The clearest examples of construction delays are the chemical complexes at Tomsk and Tobol'sk in Siberia. As originally planned in the early 1970's, these huge plants would take advantage of the petroleum and natural gas resources of Siberia and would be the largest plants in the USSR. However, these optimistic plans did not materialize; no synthetic rubber capacity was installed at Tobol'sk and designs were scaled back at Tomsk, although the plants remain among the largest in the Soviet Union.

The delays experienced at Tomsk and Tobol'sk are striking since the Siberian projects were so widely heralded, but the story is the same at nearly every chemical plant commissioned in the 1970's and 1980's.[21] These construction delays are the clearest signal that

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[17] Francis Rushing, "Soviet Chemical Industry: A Modern Growth Sector," in Soviet Economy in a New Perspective. Washington: U.S. Government Printing Office, 1976, p. 545.

[18] Philip Hanson and Malcolm R. Hill, "Soviet Assimilation of Western Technology: A Survey of UK Exporters' Experience," in Soviet Economy in a Time of Change, Volume 2, Washington: U.S. Government Printing Office, 1979, p. 594.

[19] Western estimates are usually much higher, depending on the definition of "lead-time." One source estimates that construction alone takes five to ten years, and this does not include the design or debugging phases. Ronald Amann and Julian Cooper, Industrial Innovation in the Soviet Union, New Haven: Yale University Press, 1982, p. 202.

[20] Narkhoz, various years. A new series was introduced in the 1985 handbook, based on capital investment instead of current construction costs. Using this data yields estimates of 5,616 million rubles in 1984 and 5,985 million rubles in 1985, but these estimates are in "comparable" (1984) prices.

[21] Matthew J. Sagers and Theodore Shabad, a forthcoming book on the Soviet chemical industry, 1986.

the USSR has had difficulty assimilating new technology, but there are other signs as well, notably the overall technical level of the chemical industry, the continued reliance on imported technology, and the relative performance of chemical plants installed in the USSR versus those in the West.

The technological level of the Soviet chemical industry was consistently below that of the chemical industries of the West from the 1940's to the 1970's,[22] and this pattern was predicted to persist because of severe problems with Soviet industrial research and development. A modern chemical industry is highly research-intensive, and its recent developmental pattern in the West has been that of a dynamic growth sector with a high rate of innovation and technological advance. Validating earlier predictions, Gorbachev identified shortcomings in Soviet chemical R&D as a major problem. Although Gorbachev cited specific examples of research institute inefficiencies, these comments were edited out.[23] Criticism of chemical machine-building R&D culminated in the abolishment of several research institutes, as announced by Ryzhkov on June 18, 1986, while chemical R&D is to be "reconstructed." [24]

Soviet chemical R&D shortcomings are reflected in continued dependence on imported technology. Unlike the Japanese, the Soviets have not been able to limit their purchase of licenses and equipment from innovating countries to a one-time creation of a starting base for domestic development of the chemical industry. Instead, the Soviets have had to keep on purchasing new equipment and licenses to make up for the lack of effective indigenous R&D.[25] Although the 1970's and 1980's saw some domestic developments, the dominant motif is continued reliance on imported technology, which is reflected in the shares of chemical production attributable to imported equipment presented in Table 4.

Out of the important modern subsectors, synthetic rubber production is the least dependent on imported technology.[26] But even the development of synthetic rubber production in the USSR has not been totally devoid of injections of imported equipment. During the 1970's, the Soviets imported single-stage butadiene units from Japan for petrochemical plants at Nizhnekamsk and Tobol'sk, a chloroprene assembly was installed at Yerevan in 1980, and several rubber processing assemblies for the production of tires were purchased.

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[22] See Ronald Amann and Julian Cooper, Industrial Innovation in the Soviet Union. New Haven: Yale University Press, 1982, pp. 127-211, and Ronald Amann, Julian Cooper, and R.W. Davies, The Technological Level of Soviet Industry. New Haven: Yale University Press, 1977, pp. 227-269. For a Soviet view, see G.M. Borisovich and M.G. Vasil'yev, Nauchno-tekhnicheskiy progress i ekonomika khimicheskoy promyshlennosti. Moscow: Khimiya, 1977.

[23] *Trud*, June 12, 1985 p. 1.

[24] *Izvestiya*, September 4, 1985, p. 2.

[25] For a comprehensive account of the recent development of the Soviet chemical industry see Matthew J. Sagers and Theodore Shabad, a forthcoming book on the Soviet chemical industry, 1986. Information on technology imports since 1970 was collected by the author from Soviet sources and the American journal Hydrocarbon Processing; an edited version of this data base is presented in Chapter 12 of Sagers and Shabad.

[26] The chemical industry can be divided into two groups: the older branches of mineral and basic chemistry which require simple technology and the modern or "progressive" subranches in which technical advance has been very important, namely synthetic rubber, plastics, synthetic fibers, petrochemicals, and special purpose products such as multinutrient fertilizers, herbicides, pharmaceuticals and highly refined substances for applied electronics.

Mineral fertilizer production is next in the ranking of import dependent subbranches. Soviet success in the production of simple mineral fertilizers is primarily due to its rich natural endowment of phosphate and potash and the relatively simple technology employed in the mining of these minerals. Although Soviet output of potash and phosphoric fertilizer is mostly independent from imported technology, the exact opposite is true for the important nitrogenous fertilizers and the advanced complex fertilizers which combine all three nutrients. Soviet production and exports of nitrogenous fertilizers expanded greatly during the 1970's and 1980's, due to the purchase of 29 ammonia plants and 10 urea plants, financed under compensation agreements.[27] These imported plants now account for 70 percent of Soviet ammonia production and 74 percent of urea.[28] In 1973, imported technology accounted for 74 percent of Soviet multinutritional fertilizer output, and scattered evidence indicates that this share probably has not declined.[29]

The other modern branches of the Soviet chemical industry are much more dependent on imported technology. The single most dependent subsector is synthetic fiber production, with most of the various types of fiber produced on imported equipment. Plastics production is also highly dependent on imported technology, and many of the plants that produce primary petrochemicals for plastics production have been imported. The USSR is a large net importer of paint and dye products and of pesticides and herbicides; subsectors which were slighted in terms of foreign equipment imports in favor of developing capacity in plastics, fertilizers and synthetic fibers.

Technology assimilation problems are reflected by the relative performance of imported equipment installed in the USSR. Although the Soviet press is full of anecdotes about the misuse of imported equipment, breakdowns and increasing capital repair costs in the chemical industry, it is hard to quantify this data. One survey of British chemical equipment exporters queried respondents on the performance of the equipment they had installed in the USSR, and there was some inferential evidence pointing to the Soviet inability to exceed the guaranteed level of output, although Western purchasers were expected to exceed this level routinely.[30] A different slant on this point is provided by capital productivity studies which indicated that at the margin, imported capital was more productive than domestic capital in the Soviet chemical industry.[31]

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[27] Soviet compensation agreements with the West are detailed in Jeanine D. Braithwaite, "Soviet Foreign Trade in Chemicals," Chapter 11 in a forthcoming book on the Soviet chemical industry by Matthew J. Sagers and Theodore Shabad, 1988.

[28] V. Klochek *et al.*, Soviet Foreign Trade: Today and Tomorrow. Moscow: Progress Publishers, 1985, p. 80.

[29] Share from Vneshnyaya torgovlya, No. 10, 1974, p. 45. In the mid-1970's, the USSR purchased five multinutrient assemblies from the West, with capacities from 1-1.4 million tons each. Soviet multinutrient fertilizer production in 1980 was not more than 7 million tons, so it is reasonable to assume that the share of output produced on imported equipment did not fall over the period.

[30] Hanson, 1979, p. 596.

[31] Donald W. Green and Herbert S. Levine, "Implications of Technology Transfers for the USSR" in NATO Colloquiem, *East-West Technological Cooperation*. Brussels: NATO, 1976. Donald W. Green and Herbert S. Levine, "Macroeconometric Evidence of the Value of Machinery Imports to the Soviet Union" in John R. Thomas and Ursula M. Kruse-Vaucienne (Eds.), *Soviet Science and Technology: Domestic and Foreign Perspectives*. Washington: George Washington University Press, 1977.

B. LABOR

Labor productivity goals traditionally receive considerable attention in the press, and the 12th FYP calls for labor productivity in the chemical industry industry to increase 29–31 percent, an ambitious goal. Although labor productivity in the chemical industry has grown faster than the industrial average, the increase from 1980 to 1985 only amounted to 23 percent. At the same time, it must be noted that labor itself is not all that significant a factor in chemical production. Most of the growth in chemical output and in labor productivity is due to capital inputs, not labor inputs, because chemical technology is so capital-intensive. For example, a 1977 study of labor productivity estimated that less than one-quarter of labor productivity growth was attributable to labor directly, through "improved labor organization", i.e. reducing personnel and increasing productivity.[32] The other three-quarters was due to capital-related factors such as improving "the technical level of production" (increasing the scale of production), changing "the volume and structure of production" (capacity assimilation, reducing bottlenecks, improving supply, and reducing equipment idle-time) and the introduction of new capacity.

The real significance of labor as a factor for chemical production is not in its aggregate productivity growth, but in the pattern of its allocation. The decision to shift the center of energy and chemical production to Siberia created some site-specific labor shortages due to the unattractiveness of that area to skilled workers and its inadequate social infrastructure. Inadequate infrastructure caused a site-specific labor shortage even in the mild climates of the Ukraine due to the absence of houses for workers.[33]

Although chemical technology is not especially labor-intensive, the chemical industry did foster the development of a labor-saving technique in the 1960's: the Shchekino method. In brief, the Shchekino method consisted of reducing the work force at a plant but not the wage fund and distributing the retained wages according to labor productivity. The Shchekino nitrogenous fertilizer plant which pioneered this method managed to increase output, labor productivity, and wages while releasing 23 percent of the work force from 1966 to 1980. However, the method did not diffuse throughout the economy—in 1982, only 6 percent of enterprises in the RSFSR had adopted the method. The reluctance of enterprises to adopt the Shchekino method was probably due to its undercutting by planning authorities. Even at the original plant, planners responded to reductions in the work force by decreasing the wage fund, eliminating incentive payments in 1975. The net effect of the Shchekino method amounted to the release of 968,000 workers during the 10th FYP, and there have been no recent reports about the method.[34]

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[32] Zh. Mendeleyeva, No. 2, 1977, p. 180.
[33] Izvestiya, December 6, 1981, p. 2.
[34] *Voprosy ekonomiki*, No. 2, 1983, pp. 58–68 and *Pravda*, June 14, 1982, p. 3.

III. Foreign Trade Performance

The Soviet leadership views the chemical industry as having "dynamic export potential" and the text of the Chemicalization Program includes a plank on foreign trade. Besides strengthening bilateral trade agreements with CMEA, the plank calls for the development of mutually beneficial economic ties with capitalist countries in chemical trade and improvement in the structure of trade turnover. The USSR is quite concerned with increasing the share of the "progressive" chemical products in export revenues, which translates into reducing the share of simple mineral fertilizers in chemical export revenues (around 40 percent). This section of the program calls for the creation of an "economic mechanism" to stimulate the production of high quality, competitive chemical exports.

This interest in chemical trade is hardly surprising since the Soviets have preferred to finance equipment imports by selling back part of the plant output to the equipment supplier through compensation deals. The importance of compensation agreements for the recent development of the Soviet chemical industry can hardly be overstated; in the 1970's nearly every plant purchased from the West was accompanied by a product buy-back deal.[35] Under existing agreements, the USSR is obligated to sell back 2,825,000 tons of ammonia, 1,191,000 tons of urea, and 380,000 tons of methanol every year. The Soviets have only recently begun to meet these contractual obligations; deliveries of ammonia and urea were to commence in 1978 while this level was only achieved in 1983 for urea and in 1984 for ammonia. Deliveries of methanol were to begin in 1981, but 1984 was the first year that this level was met. The reason for the delay in meeting the contracts was already explained in Section II, namely that the startup of most major chemical projects was delayed.

Compensation agreements seem to have been a phenomenon of the late 1970's since none have been reported with Western countries during the 1980's. This was partially due to Western reluctance to accept product pay-back in a relatively weak world chemical market.[36] Soviet enthusiasm for such agreements remained high, and it is likely that some petrochemical and chemical plants will be proposed for joint ventures with the West since most plant managers are already familiar with foreign equipment. Also, the new decree on foreign trade, which will allow some ministries and enterprises to trade directly with foreign firms,[37] may encompass some trade in chemical products.

The Soviet Union historically has been a large net importer of chemical products and equipment as can be seen in Tables 6 and 3. Not only is the USSR dependent on chemical product imports, but the structure of its trade pattern is skewed. Generally speaking, the Soviets import advanced chemical products and technology from the West and sell simple mineral fertilizers and basic chemical products in return. The increasing share of export revenues at-

[35] Braithwaite in Sagers and Shabad, 1988, Chapter 2.
[36] European Chemical News, July 22, 1977, pp. 4–12, and July 21, 1978, pp. 32–67, passim.
[37] Sotsialistieheskaya industriya, September 23, 1986, p. 1.

tributable to primary petrochemicals and ammonia has ameliorated this pattern somewhat, but interest in improving the pattern of trade remains keen since chemical exports earn hard currency. Additionally, the hard currency shortage currently affecting the USSR makes the reduction of chemical imports imperative since chemical products and technology purchases require scarce hard currency. In 1984, chemicals accounted for about 2.6 percent of hard currency export revenues and for 5.5 percent of hard currency import expenditure.[38]

TABLE 6.—TRADE IN CHEMICALS

[Million foreign trade rubles (FTR)]

Year	Imports	Share (percent)	Exports	Share (percent)	Trade balance
1960	127.1	2.51	125.1	2.50	−2
1965	299.7	4.13	195.3	2.65	−104
1970	454.8	4.31	296.1	2.57	−159
1975	1,046.1	3.92	675.4	2.81	−371
1976	995.8	3.47	641.5	2.29	−354
1977	1,064.4	3.54	718.7	2.16	−346
1978	1,156.0	3.35	808.4	2.27	−348
1979	1,432.8	3.78	975.6	2.30	−457
1980	2,033.5	4.57	1,313.2	2.65	−720
1981	2,275.6	4.32	1,637.3	2.87	−638
1982	2,071.0	3.67	1,596.8	2.53	−474
1983	2,286.0	3.84	1,708.9	2.52	−577
1984	2,557.3	3.91	2,192.5	2.95	−365
1985	3,029.2	4.38	2,337.1	3.23	−692

Notes.—Chemical exports and imports exclude trade in natural and synthetic rubber since the series was discontinued in 1976. These calculated shares do not match those given in the front section of the trade handbook because of this exclusion, and omitted data on explosives and pyrotechnics. Imports include data on synthetic and artificial fibers.

Trade balance is exports less imports.

source: "Vneshnaya torgovlya SSSR," various years.

It is difficult to see where the 12th FYP goals leave much room for improving the unsatisfactory trade pattern. If plastics and fibers are to increase some 40 and 30 percent, then much of primary petrochemical production will have to go for domestic production, not exports. Conversely, if export levels are maintained, then consumption targets for MBMW, construction, and domestic consumers may require continued imports of plastics and fibers.

IV. Conclusions

The Soviet leadership has set out an ambitious plan for the development of the chemical industry through the year 2000, as indicated in the 12th FYP and the text of the Chemicalization Program. The quantative targets by themselves necessitate the introduction of new capacity, but the tenor of comments at the Party Congress seem to indicate that new capacity should be obtained from domestic production. However, it is quite clear that the Soviet chemical machine-building industry cannot provide the necessary equipment for plastics and synethtic fibers production. The chemical machine-building industry has little experience with the creation of the large plants needed in these sectors since virtually all of the plants installed in the 1970's were imported. Although some

[38] Calculated from Handbook, 1986, p. 72.

Soviet sources claim that the problem is solely in the structure and organization of chemical R&D, the fact is that the Soviets have hardly any experience in designing prototype chemical plants, let alone the massive units used in modern chemical production. Only a few of the developed Western countries have the expertise to design and build these advanced assemblies. Although the Soviets have realized gains by "reconstructing" old plants instead of building entirely new structures, it should be recognized that most of this reconstruction has required imported equipment. The savings result from decreasing the length of lead-time since the construction of entirely new buildings is not required.

Additionally, there are no real indications of a Soviet "learning curve" in chemical production. When the Soviets decided to expand ammonia production, they imported more ammonia plants from the U.S. When capacity expansion in plastics was called for, the Soviets purchased a series of plants from West Germany, France, Italy and Japan. With synthetic fibers, the Soviets imported not only the fiber plants themselves, but also the plants which produced the monomers for fiber production. Synthetic rubber is the only sector in which the Soviets have relied primarily on domestic machinery.

Some progress towards increasing production can be obtained if the Soviets manage to reduce input supply bottlenecks to fully utilize existing capacity. For example, polypropylene production at Tomsk was only about 28 percent of capacity in 1982 and another 72,000 tons could be obtained from eliminating this bottleneck. About 80,000 more tons of polystyrene could be obtained at Shevchenko if ethylene supply problems were solved. Another 80,000 or so tons per year of polyvinyl chloride might be obtained from Sayansk if the production process were debugged. An additional 250,000 ton polyvinyl chloride plant is currently under construction as well.[39] The assimilation of this excess and new capacity and incremental gains at other plants should increase Soviet plastics production by at least half a million tons over the next five year. However, the 12th FYP calls for increases of 1.8–2.1 million tons. Additional new capacity is clearly required if these goals are to be achieved.

Furthermore, the installation of new capacity in the production of final chemical products such as plastics and synthetic fibers necessitates the prior installation of extra capacity for the required monomers. Not only do the Soviets lack the ability to design and domestically manufacture the equipment for 1.5 million tons or so of extra plastics capacity, but it is unlikely that they will be able to increase monomer production as required, without significant equipment imports.[40] Even though new capacity in plastics production was added by the installation of imported equipment in the 1970's, Soviet requirements increased apace and plastics imports continued to constitute about 18 percent of all chemical product imports during the 1980's.[41]

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[39] Sagers and Shabad, 1988, Chapter 8.
[40] See Sagers, this volume.
[41] Braithwaite in Sagers and Shabad, 1988, Chapter 11.

The situation in synthetic fiber production is an even more extreme version of the assessment for plastics, since this sector is more dependent on imported equipment. Synthetic fiber imports comprise only a small share of Soviet chemical imports (between 3 and 6 percent in recent years) as they have been used primarily for the production of consumer goods. However, Soviet requirements for synthetic fibers will increase if the Chemicalization Program goals for heavy industrial use are met.[42] The 12th FYP calls for synthetic fiber output to increase by 33 percent, a target which probably exceeds the available excess capacity from supply bottlenecks.

The picture is somewhat more encouraging for mineral fertilizers and synthetic rubber, which have 12th FYP targets below the industry-wide average. Although simple mineral fertilizer output has steadily increased, the nutrient content of Soviet fertilizers lags significantly behind the West because of the low level of production of multinutrient fertilizers. The 12th FYP does not specify a target for multinutrient fertilizers, but rather indicates a growth rate of 24–30 percent for total fertilizer production. Soviet synthetic rubber production is relatively independent from Western technology, and production increased about 7 percent during 1980–1985. Of course, this is not the sort of performance mandated in the 12th FYP, which calls for an increase of some 23–32 percent.

The most unlikely planks of the Chemicalization Program are the proposed increase in the deliveries of chemical products to consumers and the improvement of the import side of the trade patterns. It is clear that the production of plastics and synthetic fibers will not meet projected industrial needs without major additions of new capacity, and it is hard to envision large increases in product deliveries for consumers when industrial targets are in doubt. It does seem likely that the USSR will continue to rely on chemical product imports, while the emphasis on the acceleration of scientific and technical progress will probably worsen the structure of imports as more revenues will be spent on the advanced chemical products produced in the West. As long as the USSR honors its compensation agreements, the export of primary petrochemicals should continue to improve the structure of chemical exports. However, if 12th FYP targets are deemed more important than increasing the share of "progressive" chemical products in exports, the share of export revenues attributable to simple chemical products may actually increase.

Overall, the Chemicalization Program amounts to a very taut plan for increasing Soviet chemical production. It is difficult to see how all these targets can be met, let alone in the absence of significant equipment imports. However, the chemical industry has been allocated a major increase in investment funds, and tenative signs about joint ventures and foreign trade must not be overlooked. Chemical equipment imports will increase if the Soviets are all all serious about their Chemicalization Program.

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[42] In 1983, only 19.5 percent of chemical fiber output was used in tire production and 1.6 percent in agriculture (for binding twine), while the light and food industries accounted for the rest of consumption. Listov, 1984, p. 14 and p. 18.

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COMMENTARY

By Philip Hanson*

Summary

The studies in this section show that Gorbachev's industrial modernization drive is being conducted in a rather old-fashioned Soviet manner. In particular, it is being managed "from above", and it is generating over-ambitious plan targets. In this commentary it is shown that policy towards the research and development sector, like industrial investment policy and output targeting, is rather traditional in approach. It does not, however, necessarily follow that Gorbachev's industrial modernization program is doomed to fail. It is important to allow for several factors on which our knowledge is only sketchy: the impact on productivity of the "new broom" effect of the personnel shake-out and the attempt to sharpen worker incentives; the influence of possible resource transfers (at the margin) from military production, and the contribution of imports—including imports from Eastern Europe. It is also important to remember that accelerated hidden inflation may create a statistical illusion of success in some key indicators. Some criteria are suggested for assessing the program's success in the next few years.

I. The Style of the Modernization Drive

In industrial economies, new products and processes are constantly being introduced and diffused in all lines of production. The activities which generate most of them, however, are concentrated: they center on engineering production and research and development (R and D). And much of the implementation of new technology requires investment. There is therefore nothing strange about the present Soviet leadership's decision to channel an increased proportion of resources into R and D, the engineering sector and investment. They are acting on the judgment that these growth-generating activities were neglected from the mid-1970s on.

Two aspects of Gorbachev's modernization drive, however, give rise to doubts: the large scale and abruptness of the priority shifts, and the reliance on pressure from above rather than on reforms which would strengthen incentives to raise productivity. In other words, priorities are being changed in directions which make good sense, but the change is being implemented in the old style, with a strong probability that many plan targets are too taut and that

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bottlenecks will be a serious problem. This is not to say that the modernization drive will do nothing to accelerate Soviet industrial growth; it may well do something. What it does not seem likely to do is to put Soviet industry on course to becoming competitive with the more dynamic Western economies. That, at any rate, is the impression given by the Twelfth Five-Year Plan (12 FYP). We have no useful information on policies for the 1990s; the handful of perspective-plan targets for the year 2000 seem to have been selected by a basketball coach, with height as the main criterion.

There are some signs of an "intensive" and "reform" approach which the Soviet planners have pointed to. Ryzhkov, in his speech at the Party Congress, said that in 1986–90 some key input-output ratios were to be reduced: for example, a 1.7 percent a year growth rate for steel rolling-mill production was to be obtained with almost no growth of coke and iron ore production, and that modest growth of steel output, in turn, was to support a growth rate of at least 7 percent a year in machine-building and metalworking (MBMW) output.[1] Talyzin, introducing the 1987 annual plan, claimed that the practice of planning each year from the achieved level was being abandoned in favor of adherence to the initial five-year plan—though only some of the 1987 targets seem to follow this rule.[2] The more efficient use of material inputs, however, is being sought through centrally-decreed targets, not through changes in the institutional framework; and the abandonment of planning from the achieved level has yet to be demonstrated in any instance where it hurts—that is, where the output of an industry or product-group has fallen short in year 1 of the level prescribed for year 1 in the five-year plan, but the annual-plan target for year 2 remains at the level set for year 2 in the five-year plan.

If the system is going to work, for the time being, in much the same way as it has in the past, analyses of the 12 FYP that are based on past performance must be taken seriously (though some qualifications to this are considered in part III of this paper). The papers by Leggett and Kushnirsky suggest that the 12 FYP will encounter bottlenecks at the level of national and sectoral totals. These difficulties ought to show up in independently-conducted studies of at least some particular branches and product-groups, and the other papers in this section do indeed tend, on the whole, to support the more aggregated studies. The same diagnosis, of an over-ambitious plan, is reached in several other Western studies;[3] indeed, as Kushnirsky points out, a number of Soviet economists have expressed the same view. The rest of this paper summarizes the evidence for bottleneck problems, adding some questions about the R and D sector in particular (section II); considers some influences which may nonetheless be helpful to plan fulfillment in reality (section III) and in appearance (section IV), and concludes (sec-

[1] *Pravda* March 4, 1988.

[2] *Pravda* November 18, 1986.

[3] Hanson, "The Soviet Twelfth Five-Year Plan," paper presented at the NATO Economics Colloquium, Brussels, April 1987; H.S. Levine and B. Roberts, "Soviet Economic Prospects and Their National Security Implications," paper presented at the NATO Workshop on National Security Issues after the 27th Party Congress of the USSR, Brussels, November 1986; J. Noren, "Soviet Investment Strategy under Gorbachev," paper presented at the AAASS meeting, New Orleans, November 1986; B. Rumer, "Realities of Gorbachev's Economic Program," *Problems of Communism*, May-June 1986, pp. 20–31.

tion V) with a review of indicators to watch in order to assess the progress of the industrial modernization drive.

II. Likely Bottlenecks

The modernization drive is at the core of an obviously ambitious medium-term plan. National income utilized is supposed to grow at 4.1 percent a year in 1976–80, against 3.2 percent a year in 1981–85. Yet labor inputs into material production are apparently expected to increase at only about 0.2 percent a year, against 0.4 percent a year in the previous five years; [4] and productive fixed capital stock is planned to grow 1 percent a year more slowly than in 1981–85 (5.4 against 6.4 percent a year). Even if sown area stabilizes (it had been falling slightly), it is obvious that any measure of total factor input growth will show a deceleration. Therefore plan fulfillment requires a remarkable improvement in the rate of productivity change. (With the 1982 factor-share weights used by the CIA for calculating total factor productivity change in GNP, total input growth would be planned to slow from 3.1 to 2.6 percent a year, and total factor productivity growth—in Soviet-definition national income utilized—would have to rise from 0.1 to 1.5 percent a year.)

The odds against such an acceleration must be high. The adverse effect on productivity of worsening natural-resource conditions is not expected to diminish. At the same time, the positive effect of inter-sector resource shifts, insofar as that effect depends on the movement of labor from the farm sector to industry, is more likely to diminish than increase. Sharp improvements in productivity growth are nonetheless being counted on. It appears that they would have to come from some combination of the following: improvements in average weather; the widening of key bottlenecks; further increases in the special earnings of foreign trade (which have contributed significantly to recent national income growth as officially measured); improved morale and effort, and faster technological change, in the sense of faster introduction and diffusion of new products and processes and of improved labor skills. Apparently a great deal is being expected from those of the possible benign influences over which the policymakers have some control.

It is therefore not surprising that analyses of the modernization drive arrive at skeptical conclusions. There are inconsistencies in it that are sufficient to cast doubt on the feasibility of the main targets.

A. Bottlenecks at National and Sectoral Levels

Noren's analysis of the 12 FYP investment program concluded that an implausibly high growth of total output was being projected. In the present volume, Kushnirsky's and Leggett's conclusions support this judgment. In addition, they both conclude that the planned growth of MBMW output (somewhat under half of which has in recent years been final machinery output for domestic in-

[4] Planned labor input growth derived from planned total labor productivity growth on the assumption that national income produced is set to grow 0.3 percent a year faster than national income utilised.

vestment) is unlikely to be enough to support the planned growth of equipment investment. Levine and Roberts reach the same conclusion, with the proviso that a drop in the growth rate of military hardware production might allow a sufficiently rapid growth of producers' durables output for domestic investment.[5]

Both Noren and Levine and Roberts—though using different methods of assessment—concluded that total energy supplies were not likely to be a constraint on planned output growth, but that supplies of non-fuel basic materials were likely to be a bottleneck. That conclusion is not undermined by the branch studies in this section.

Research and development can also be treated as a sector—albeit a sector made up of research and design organizations scattered across the various branch-ministries. An important aspect of the modernization drive is the increased priority given to this sector. Current expenditure on "science" is to rise by 5.9 percent a year in 1986–90, and capital spending by 11.2 percent a year.[6] Some increase in resource priority for R and D probably makes good sense. Greater attention to R and D hardware in particular—especially measuring and testing equipment, pilot plant facilities and the like—should help to correct an imbalance that has been much complained about. The dimensions of the shift, however, seem exaggerated.

Some acceleration of the growth and R and D staff numbers must be intended. Yet the absolute number of Soviet research scientists and engineers is generally considered to be excessive already, and research institutes have been extensively criticized in leadership speeches for being (in many cases) inflated in size and low in productivity. It is true that Western development in this sector has recently made more use of "extensive" growth than Soviet R and D has done. The growth in the numbers of Soviet research scientists and engineers, and in R and D expenditure, slowed considerably after 1975, while in the OECD countries the volume of research activity, after a slowdown in the early 1970s, was growing quite quickly. Nonetheless, if one can judge by results, Soviet R and D employment was either over-large to begin with or most of the best people were working for the military, or both.[7] The R and D sector seems to be a clear example of talk about "intensive" progress followed by policies of extensive growth.

B. BOTTLENECKS AT BRANCH LEVEL AND BELOW

The paper by Sagers and Shabad on petrochemicals, and by Braithwaite on the chemical industry, also illustrate the problems of an ambitious plan. They do so, however, at a level that is closer to operational decison-making about particular plants and products. The present structure of oil refinery capacity is such that plans for petrochemicals put a strain on the output of light fractions; changes in refinery capacity to produce more light fractions

[5] The reference is to the articles by Noren and by Roberts and Levine cited in footnote 3.
[6] Ryzhkov speech, Izvestiya June 19, 1986.
[7] For a comparative assessment of R and D productivity, see P. Hanson and K. Pavitt, The Comparative Economics of Research, Development and Innovation in East and West, forthcoming.

have been slow in coming, and the installation of the necessary equipment is likely to produce such changes, on any scale, only in the 1990s. Meanwhile the chemical engineering industry is still heavily committed, as Sagers and Shabad point out, to providing energy-sector equipment; and, as Leggett points out, the energy sector is set to continue taking a very large share of investment. Thus the question of where the necessary new equipment is coming from, is hard to answer. This is a sector in which reliance on imported technology has been exceptionally high, and the ability to design and develop many types of new chemical plants has not been built up.

An assessment of just how taut the plan is for the chemical sector, however, is still far from easy. Capacities to make a number of key products are substantially under-utilized—often because related "upstream" capacities are not completed. Correction of some of these intra-branch imbalances may be able to generate larger-than-expected output growth. There is also uncertainty about the possible role of trade, including trade with Eastern Europe (see section IIIC below). Nonetheless, the difficulties that are likely to arise in particular industries seem to reflect the strains and stresses of a generally over-taut plan.

III. Some Influences on the Outcome

Despite the analyses provided in this section of the compendium—and despite the general tenor of my own comments so far—it would be premature to write off Gorbachev's modernization drive. The outcome will be affected by many influences of which we have only a hazy understanding. Three such influences are worth a brief discussion here; all of them might be helpful to Gorbachev's program, and none of them has received the attention it merits.

A. THE NEW-BROOM EFFECT

In capitalist economies there is a social-interest case for corporate raiders. Competition in the product market is generally imperfect, and does not ensure that all companies must be close to maximum X-efficiency merely to survive. The corporate raider descends on companies that are using resources relatively poorly. He may or may not acquire a particular company, but either through acquisition or through a successful fight against acquisition the company rationalises its activities and ends up leaner and fitter. There is also a social-interest argument against corporate raiders: that the stock market allows very short-term considerations to predominate, so that a corporate raider can descend on a company that already is—in a longer-term perspective—lean and fit, and divert resources to the socially unproductive activity of fighting off bids.

Mikhail Gorbachev is a corporate raider who is doing his best to take over a particularly large company, USSR Inc; to carry out a management shakeout and a change of product-mix; and to launch the unwieldy conglomerate on a new and higher growth path. It is worth considering him in that light.

The Soviet case is surely one in which a corporate raider can do some good. Brezhnev's policy of stability of cadres allowed indolence and corruption to flourish among senior industrial officials. It

also must have made it easier for branch ministries to resist pressures from the central policymakers to accept more demanding tasks. At the time of writing, Gorbachev has replaced about 40 out of 90 heads of ministries and state committees. This should have had some effect in breaking up mutual protection circles, and making all office-holders inclined to try harder. Corrupt and incompetent officials have been replaced—if only by men who have not yet had their predecessors' opportunities. Some improvement in X-efficiency as a result is at least a plausible hypothesis. The anti-alcohol campaign may also contribute something to output growth in the medium term. We have no established way of assessing such effects, but some gains of this sort from the new-broom effect of a new leader may be forthcoming—as they seem to have been initially under both Khrushchev and Brezhnev.

B. TRANSFERS FROM THE MILITARY

There is some evidence that the allocation of investment within the engineering (MBMW) sector is being shifted from mainly-military to mainly-civilian branches.[8] Perhaps, too, a larger-than-usual share of the increment of MBMW final output will be producers' durables (the remainder would be military hardware and consumer durables). There is also evidence of increased efforts to transfer management know-how from military to civilian production.[9] The logic of this maneuver might extend to civilian and military shares in R and D. If it did, the argument put forward in section IIA, about extensive development of the R and D sector, would lose some of its force. In Soviet R and D with its present mix of activities, it is likely that more means worse, but a shift from military to civilian activities would probably raise the average quality of the latter.

The possible shift from "military" to "civilian" is not necessarily opposed by the military and military industry. It would be a shift, at the margin, from military production at current Soviet technological levels to the development of a cluster of electronics-based products with military as well as civilian applications in the long term. Therefore the military might well put their influence behind it. Needless to say, however, scenarios of this type are a matter of speculation on the part of Western analysts, with only limited evidence.

C. FOREIGN TRADE

One influence on the modernization drive will be what the Soviets can gain from imports of capital goods and advanced technology. Two assumptions are commonly made at present: that machinery imports from the West are unlikely to grow significantly in the late 1980s, and that it is only imports from the West which are important in this connection. In both respects, however, the prospects may not be quite as bleak for Moscow as they appear.

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[8] R.W. Campbell, "Resource Stringency and the Civilian-Military Resource Allocation," mimeo, October 1986.

[9] J.M. Cooper, "Technology Transfer between Military and Civilian Ministries," in this volume.

There is no doubt that Soviet hard-currency earnings prospects have been damaged by the 1981–86 slide in energy prices. It is also true that Gorbachev, Ryzhkov and Ligachev have all spoken emphatically about the dangers of dependence on imported Western technology. On the other hand, the plan targets themselves will generate pressure from the branch ministries for Western machinery; the competition between Western taxpayers to reduce other people's food bills has helped the Soviet balance of payments considerably and will probably continue to do so; and there may well be a reduction in the volume of Soviet farm imports. These considerations make some growth of machinery imports from the West more likely.

In addition, there is the possibility that we may underestimate the contribution that imports from Eastern Europe can make. It is true that East European machinery—particularly the machinery that the East Europeans make available to the Soviets—is not going to be technologically competitive, as a rule, with its Western counterparts. It is also true that East European capacity to provide more is limited by the lack of net investment in the smaller CMEA countries in recent years, and the Soviets' CMEA purchasing power will not be growing strongly. Nonetheless, it is worth bearing in mind that the East European contribution is not trivial. For example, Soviet imports of chemical equipment (ETN 150 in the foreign trade classification) from Eastern Europe in 1984–85 were on a similar scale to the imports from the West; each was contributing something on the order of one-third of total Soviet equipment investment in the chemical industry, and the imports from Eastern Europe were tending to rise faster than those from the West.[10]

IV. The Problem of Concealed Inflation

A final consideration relates to appearance, not reality. Gorbachev's industrial modernization drive sets particularly high targets for two activities: equipment investment and MBMW output. Both are officially reported in series that are known to be subject to concealed inflation: subject to concealed inflation, that is to say, to a degree which exceeds that of Soviet output in total. (The extent of the problem is better understood for MBMW output than it is for equipment investment.) Much of this concealed inflation comes about from the manipulation of "new product" pricing rules to the producers' advantage; phoney innovation has become a standard device for meeting ruble-value targets, not to mention targets for introducing new technology. Under the pressure of sharply increased targets for these activities, the pursuit of phoney innovation as a dodge for raising reported "performance" is in danger of becoming even more of a national sport than it already is. To put it another way: Gorbachev's new priorities are of a kind which the Soviet system is particularly good at pretending to meet. The new state quality control arrangements will work against this, but they may well not stand up to the strain.

[10] Derived from Vneshnyaya torgovlya SSSR v. 1985 and Narkhoz 85 p. 368, assuming that about 40 percent of chemical industry investment is equipment, and that Western machinery is priced domestically at its valued ruble price, as P. Bunich states in "Samofinansirovanie osnovnogo zvena," Voprosy ekonomiki 1986 no. 10, pp. 14–24.

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This is not a trivial point. Appearances often matter more than reality, and even the merest illusion of success will help Gorbachev politically.

V. Indicators for Future Assessment

Gorbachev's modernization drive relies too much on pressure from above and over-taut plans to be conducive to a genuine transformation of the Soviet industrial scene: that is the consensus view, and I think it is probably right. On the other hand, the new-broom effect, together with the correction of past errors, does provide grounds for anticipating some improvement in productivity growth. That is so, even though no breakthrough to general technological dynamism seems likely.

Any such improvement would show up in the growth of those industrial outputs which are reported in physical terms: not only basic materials and fuels but also bulk chemicals, cement, paper and the like, as well as some more highly fabricated products (e.g., plastics) which are reported in tonnage terms. The key areas of technical progress in machinery, however, and of investment volume, are not going to be reliably depicted in Soviet statistics. The best measure of progress in the technical sophistication of machinery and other manufactures will be Soviet export performance on competitive markets.

IV. DEFENSE INDUSTRY AND THE ECONOMY

OVERVIEW

By Richard F. Kaufman*

The papers in this section bring new light to the linkages between defense production and the Soviet economy, the burden of defense, and the problems of defense measurement. Establishing the connections between defense and the economy is no easy task. Even in the West where much more information about defense is known than in the Soviet Union, there are many questions about these interactions. The problem is exacerbated in the Soviet Union because of Soviet secrecy concerning defense. Nonetheless, there is much information about Soviet defense and economic performance from which reasonable inferences and conclusions can be drawn.

The lead-off paper by Abraham S. Becker probes "Gorbachev's Defense Economic Dilemma." Gorbachev came into power facing economic stagnation at home and a growing military threat abroad. On one hand, the United States was in the midst of a defense buildup while Soviet defense spending had been on a plateau. On the other hand, the heavy burden of military spending was already a drag on the Soviet economy. Increasing military spending to meet the perceived threat could compromise Gorbachev's domestic program.

Becker shows that Gorbachev's driving concern has been to revitalize and transform the Soviet economy. To achieve these ends, Gorbachev has advocated "radical" reform of "revolutionary" dimensions. Although it is not possible to know with certainty whether there will be a shift in resource allocations from defense to the civilian sector during the 12th Five Year Plan period (1986–1990), there are signs pointing in that direction.

A concrete indication of Gorbachev's commitment to economic over military development, Becker writes, is "the increasing conscription of defense industry to aid civilian production." He argues that without the extended cooperation of defense industry the planned modernization of the machine-building industries would be completely infeasible. The decision has been made to use defense industry expertise and experience in the production of civilian goods and in the technical re-equipping of the light and food industries, public services, and trade. Although this idea goes back many years and was emphasized by Brezhnev, Gorbachev may be carrying it on with greater determination. Indeed, Gorbachev's top prior-

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ity appears to be economic growth, followed by consumer welfare and then defense.

The military establishment seems to have made an accommodation with the Gorbachev program despite the implied constraints on the military budget. Becker argues that such acceptance would be based on the perceived Soviet lag in conventional military technologies and doubts in the minds of some military leaders about the ability of the USSR, burdened by a backward economy, to keep up with the accelerating pace of technological change. This is consistent with the U.S. intelligence community's view that the production capacity required to support Soviet military force modernization over the next several years is already in place.

The author goes on to say that the understanding between Gorbachev and the military might fall apart if there were significant military cutbacks to accommodate civilian needs, or if the growth of Western military power was not constrained. There might also be difficulties if there were slippages in Gorbachev's modernization program or an acceleration of Western technological progress.

Several of the important questions raised in Becker's assessment are discussed at greater length in the other papers in this section. Two contributions take up different aspects of the military burden question. Andrew W. Marshall comments broadly about the problem of measuring and understanding the full economic costs and future economic consequences of Soviet military and related programs.

Marshall believes that the existing measures of the military burden are not sufficiently comprehensive or accurate. The standard measure is the portion of GNP allocated for military activities. The difficulty is that the definition of what should be included in the military effort is too narrow in the Soviet context. He proposes a modified approach to estimating the military burden on the Soviet economy.

In Marshall's view, the Soviet military effort consists of three "tranches." The first consists of what are traditionally thought of as defense programs including men, research and development, and equipment. Second, are the resource flows to activities related to the first tranche, such as civil defense and industrial mobilization preparations. Third, is the cost of the "external empire" incurred in order to increase protection of the Soviet Union or expand its influence in the world.

Marshall's guess is that, if all these costs were totaled, they could comprise 20 to 30 percent of Soviet GNP over the past 10 years. This range is considerably higher than present official U.S. intelligence establishes which place the share of GNP allocated for defense at 15 to 17 percent. The higher figures, Marshall states, may help explain the decline in the growth rate of Soviet GNP. Further, the Soviet Union "may face requirements to invest in areas previously neglected, in part because of the large allocation of resources to the military." One example cited by Marshall is the health sector.

Murray Feshbach's paper, "Soviet Military Health Issues," can be read as a case study of the consequences of the kind of underinvestment in health referred to by Marshall. Ironically, part of the price the Soviet Union is paying for neglecting health care is

that the pattern of increased illness for the population as a whole has spread to the military.

Feshbach demonstrates the sense of urgency, if not alarm, among government officials about the incidence of disease and other medical problems in the military. Health delivery problems, the quality of care, shortages of supplies are pervasive and startling to the Western observer. For example, military medical service personnel have been urged to make savings in bandages through their reuse after laundering. Medical journals have noted the poor quality of vaccines and the practice of reusing needles because of shortages.

Military authorities acknowledge the need for improvements in sanitation and hygiene, and commissions have been formed to undertake "anti-epidemic" measures. One military official, the Chief Hygienist of the Defense Ministry, has drawn attention to deficiencies in hygiene and sanitation and the effects upon combat efficiency. This official associates the spread of intestinal infections with poor quality water, and points to shortcomings in food preparation and such mundane items as bath and laundry service.

According to one report, half of the conscripts in some military districts experience intestinal problems during their tours of duty. The same proportion suffer from dysentery at least once in two years, and one-third get it twice. The incidence of hepatitis is high and has spread throughout the armed forces. Mennigococal infections have increased and are frequently aggravated by the lack of timely diagnoses. The "childhood" diseases—especially diphtheria, mumps, and measles—have increased, and the number of deaths from pulmonary diseases quintupled between 1960 and 1979.

Feshbach also refers to other categories of military medical problems that cannot be solved just by increased allocation of resources. He concludes that the high incorrect diagnosis rates for a large number of diseases reflects poorly on the ability of physicians and others and suggests a need for reorganization of medical education, or retraining of medical personnel, or both.

The commentary by Norbert Michaud, Stephen O. Maddalena, and Michael J. Barry examines the planned growth of the civil and military machine-building industries. There are 20 machine-building industries—11 civil and 9 military. Although the civil industries produce many goods for the military, and the military industries produce many civilian goods, it is believed that the gross output of each and their rates of growth are general indicators of civilian and military production and say something about relative priorities. In addition, Gorbachev's program for modernizing industry centers on machine-building, which is the source of production equipment and final durable goods.

The authors point out that the planned output of and investment in the civil ministries has been greatly increased. For the first time, the civil machinery ministries will expand as fast as the military ones. This will not appreciably change the proportions of civil and military output. However, it is significant that there have been calls for the military machine-building sector to help the civil sector. There are other signs that there may be more emphasis on civil production in the defense industry.

Julian Cooper discusses this possibility in his paper, "Technology Transfer Between Military & Civilian Ministries." He argues that

the image of the Soviet defense industry as a distinct sector, separated from civilian industry by an almost impenetrable barrier of secrecy, is oversimplified. The separation is relative, not absolute. There are interrelations between the two and possibilities for transfers of technology. In the absence of market relations, the mediation of special agencies and mechanisms is necessary for transfers to be successful.

Among the groups that facilitate transfers of military technology to civilian industry are the scientific and technical information institutes maintained by each of the nine defense industry ministries which provide information available for application elsewhere. New technological innovations and management practices developed in the defense sector are also relayed through the press, technical journals, books, exhibitions, and conferences, and a variety of technical, academic, educational, and Communist Party groups, some of which function at local levels. The appointment of the former minister to head the newly created Bureau of Machine Building, and the appointment of other defense industry officials to high positions in civilian industry seems likely to encourage greater contacts between the two sectors.

Cooper cites examples of military technology already transferred from the military to civilian industry. These include industrial robotics, flexible manufacturing systems, rotary production lines, metallurgical technologies, and agricultural technologies. He believes that there is, under Gorbachev, a definite policy commitment to expand cooperation between the defense and civilian sectors, and that it is most developed in relation to production technology and materials. If it is correct, Cooper states, that defense industry investment needs are less intense for the next few years because of the high volume of investment during the recent past, there should be more scope for transfers from defense to civilian industry in the area of production technology.

Recent developments in defense production are analyzed by Shelly Deutch in "The Soviet Weapons Industry: An Overview." She examines the Soviet weapons acquisition process and the reasons for the major changes taking place in that area. In the past, Soviet weapons were based on relatively simple low-risk weapons designs that could be manufactured in labor-intensive factories with long production runs, and maintained in the field with a minimum of technical skill. This approach is changing because of economic and technological developments and perceptions of the foreign threat.

The Soviet weapons development style minimizes risk but encourages technological conservatism and carries the potential for obsolescence. The system provides incentives for program completion and penalties for failure. The author states, "The result is a de facto technology freeze on major system components before the weapon is developed." This traditional approach is no longer tenable in a period of rapid technological advances and increased Western military capabilities.

A change in the traditional approach appears to be under way as the Soviets shift to more sophisticated and more costly weapons. But the attempt to close the technology gap with the West is hampered by the inefficiencies and relative backwardness of the indus-

trial base. The Soviets are weakest in the electronics and related technologies required for the production of advanced weapons. According to Deutch, "The real revolution in Western manufacturing technology—the marriage of precision machine tools and microelectronics—has not fully reached the Soviet civilian or defense industries." Shortfalls in military technology and the industrial base have helped bring about recognition by the Soviet leadership that long-term defense needs require more balanced development and greater awareness of the increasing interdependence between defense and civilian industry.

Underlying all discussions about the Soviet defense sector is the difficulty of correctly measuring or estimating the amounts spent for defense and the annual rates of growth. There are two principal methodologies. The one most relied upon by the U.S. intelligence community is the direct costing or building-block approach. Under it, the physical elements of the defense effort are identified and monitored over time. The second method, known as the residual approach, seeks to discover defense costs by examining Soviet economic statistics. This approach is appealing because it does not depend upon secret information or intelligence gathering and is far less expensive than direct costing.

Bonnie K. Matosich presents the results of a lengthy investigation of the second method in her paper, "Estimating Soviet Military Hardware Purchases: The 'Residual' Approach." This method is generally used to estimate military hardware purchases on the assumption that all military machinery purchases are included in the statistics for machinery output. Analysts subtract the value of nondefense purchases from the total output data. What is left, the residual, is believed to represent the value of military machinery purchases.

The author concludes that because of the great uncertainties in interpreting the associated Soviet data, the residual methodology is unreliable for estimating the level and trend of Soviet military hardware expenses. Her conclusion is based on the problem inherent in the aproach: that various assumptions and methods used in deriving the residual can vary and cause widely differing results. For example, it can be assumed that some or all military purchases are included in the machinery output data and hidden as a residual, or not hidden as a residual and distributed among the categories of civilian purchases. It can also be assumed that some or all military purchases are excluded from the machinery data. The value of the residual method is diminished by other problems, such as the hidden inflation in Soviet statistics.

GORBACHEV'S DEFENSE-ECONOMIC DILEMMA

By Abraham S. Becker*

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Before my people, before you and before the world, I state with full responsibility that our international policy is more than ever determined by our domestic policy, by our interest in concentrating on constructive endeavors to improve our country.[1]

SUMMARY

Gorbachev came into office intent on accelerating growth and modernizing the economy. He therefore needed a stabilization of the external threat to be able to focus on his domestic program. If that could not be secured through diplomacy, he would presumably feel compelled to respond with military measures, but only at the cost of compromising his domestic program. Gorbachev's military-economic dilemma did not begin in 1985 but developed over the previous decade. The nature of the options had not changed, but by the mid-eighties the tradeoffs had deteriorated.

Does the 12th Five-Year Plan, adopted in mid-1986, provide for a step-up in military spending? Only tenuous, indirect evidence is available and it is inconclusive. However, Gorbachev's speeches and statements as well as Moscow's actions over the past two years strongly suggest that the military budget is still being constrained.

The Soviet military's views on the Gorbachev program cannot be totally unfavorable. They should certainly welcome the campaign against corruption, lethargy and alienation that have taken hold in Soviet society over several decades. On resource allocation, it seems reasonable to suppose that the military leaders recognize the future promise in the sharply accelerated investment in high-technology branches of machinebuilding. They may be prepared to trade off short term restraints on military production and procurement for the future potential inherent in a technologically sophisticated military R&D and production base.

*The Rand Corp.

[1] Mikhail Gorbachev, to an International Forum on Peace and Disarmament, Moscow, February 16, 1987. *New York Times*, February 17, 1987.

This bargain, implicit or explicit, is likely to hold, however, only as long as the conditions of the understanding are fulfilled: namely, that the sacrifice of current security interests does not become unexpectedly large and the promise of future military potential appears realizable. If military procurement has to be cut back still further, and the ambitious targets for machinery output may be difficult to achieve without tapping the resources of military production, if Gorbachev is unable to limit the growth of American military power, if the Soviet modernization program lags badly, or if Western military technical progress accelerates, the modus vivendi may be undermined, as would Gorbachev's authority and possibly even his chances of political survival.

The military may also be uneasy over the erosion of the distinctiveness and priority of the military sector as well as over the prospects for speeding up military innovation. The first has been in process for a decade or more but appears to be accelerating under renewed pressures on military industry to share the burden of civilian development and due to the very emphasis on dual-use, high-technology machinery production. Development of that technology may contribute importantly to raising the qualitative level of military production, but it is unlikely to do much for the R&D process itself. Here Gorbachev's reform of enterprise incentives will be crucial, and so far little progress has been achieved.

If the Party and the army have achieved an understanding on military resource allocation, it involves a continued acceptance of short term risks that in some military views have been mounting for close to a decade. Gorbachev's maneuver space is not unlimited, and an inability to make good on his promises could rekindle the embers of Party-military conflict.

Introduction

Gorbachev came into office in March 1985 facing problems of internal political, social and economic decay. Alcoholism, corruption, deteriorating public health, and a stagnant economy, nationalist unrest, and generally plummeting morale suggested an incipient domestic crisis of major proportions. Gorbachev clearly viewed the internal crisis as his priority concern, but he also had an external challenge on his hands. The American military revival was in its tenth year and the buildup had been particularly rapid for the past four years. Added to that was the SDI program, announced two years earlier and now just gathering momentum. As he made clear on numerous occasions, Gorbachev wanted to be able to concentrate on internal reform and therefore clearly needed a stabilization of the external threat. Could he secure that through negotiation or other political means? If not, he would, presumably, feel compelled to respond in kind, in part or in full. But given the drag on the economy imposed by the ongoing military effort, could he afford to do much more without compromising his domestic program—economic in the first instance, but the social and political as well?

This was Gorbachev's defense economic dilemma, widely understood in the West and probably among Soviet elites as well. Of course, the dilemma was not created with his accession but devel-

oped over at least the previous decade as growth plummeted, the leadership crisis turned acute and the Western political-military challenge mounted. The nature of the options had not changed, but by the mid-eighties the tradeoffs had deteriorated.

Defense and the 12th FYP

For several years, the U.S. intelligence community, particularly DIA, has appeared to see or expect resumption of the fast growing rate of Soviet defense spending and especially of procurement that it had estimated for the first decade of the Brezhnev period.[2] It seemed difficult to believe that the procurement plateau would continue indefinitely. At the same time, it was recognized that a decision to step up military spending would be fraught with serious economic, political and social consequences. What can be said then about Gorbachev's policy and actions in the two years he has been in power?

When Gorbachev assumed the General Secretaryship he undoubtedly already had in hand a fairly detailed military development blueprint for the 12th FYP. The draft of the economic plan's guideline control figures was available no later than the early spring of 1985, when it was reviewed by the Politburo. Since the major economic targets cannot be set until the military development goals are determined and translated into resource requirements, the military part of the plan must have been ready no later than the first quarter of 1985 and probably even earlier. However, the Politburo did not accept the first variant of the economic plan brought before it, or even the second. In fact it turned down three variants before it declared itself satisfied. Considerable changes were therefore introduced into the original version.

If this is the case, perhaps the military targets were changed as well. There is obviously little evidence one way or the other on this issue. Gorbachev's explanation for the Politburo's demandingness indicated that the main issue was higher output and productivity growth rates, and this might have implied the necessity for some cutback in military requirements. On the other hand, Gorbachev was the junior man on the team, in experience as well as age; he had no military or military-industrial experience; he may well have won the office on a divided vote;[3] and he certainly did not control the Politburo. These factors, along with his determination to effect significant change in domestic matters, might argue that Gorbachev was unwilling to tread unnecessarily on sensitive military toes, at least for a while.

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[2] Allocation 1983, p. 21 (DIA: ". . . the intelligence community is in agreement that there is going to be an upward trend in the growth of these forces in the next five years.") See also DIA production projections for 1983-90 in Allocation 1983, pp. 204-5. In November 1984, CIA indicated that the slowdown extended through 1982 but tentatively estimated that procurement had turned up in 1983. However, CIA also acknowledged that "for the last 2 or 3 years, we have seen the initial estimates for a year come down a bit with additional information." DIA in January 1985 maintained that the "rapid growth in the dollar value of major Soviet weapon systems evidenced in 1983 has continued into 1984" (Allocation 1984, pp. 7, 8, 14, 123). In March 1986 the two agencies presented a joint paper in which divergent positions were expressed: CIA believed that procurement continued flat in 1982-84 while DIA estimated a growth rate from 1982 through 1985 of 3-4 percent per year (Allocation 1985, pp. 16, 36).

[3] Radio Liberty reported on January 31, 1987 ("The USSR This Week", RL 45/87), that according to an article in the Soviet mass journal *Ogonek*, opponents of Gorbachev had tried to elect Viktor Grishin to the General Secretaryship in March 1985.

There is an equally strong liklehood, however, that the military plan of early 1985 did not propose a major step-up in spending. If the draft defense budget bore the imprint of Chernenko's views, it must surely have reflected a restraint on defense growth. Throughout Brezhnev's last years and in his own fleeting moment of power, Chernenko made evident his reluctance to sacrifice consumption for defense. Gorbachev may also have had a voice in determining the draft budget's general framework, since he was the de facto General Secretary at least by the winter of 1984–85. Even if he was concerned about the security threat from the West, he might well have wished to ascertain first whether it could be constrained by political means before draining precious resources away from the economic programs in which he was clearly most interested. With Chernenko evidently on his last legs, such an opportunity probably did not seem far off.

The published materials on the 12th FYP naturally provide almost no direct information on the targets for the military sector. In presenting the final version to the Supreme Soviet (*Pravda*, June 19, 1986), Ryzhkov devoted one sentence to military production: "The scale of physical output envisaged in the five-year plan makes it possible to maintain the country's defensive might at the necessary level." [4] It is therefore necessary, as with previous Soviet plans, to look for indirect evidence.[5]

It is not easy to draw firm conclusions from such an examination. The Plan is ambitious with respect to output growth rates, calls for very substantial investments in both consumer and producer sectors, and generally provides for rapid progress along a broad front. The output of Group A industry (supposedly, producer and military goods) is scheduled to increase by 4.4 percent per year but that of Group B (consumer goods) by 4.9 percent. On the other hand, "heavy" industry (machinebuilding; fuel and energy; metallurgy; chemicals; timber, wood, pulp and paper; construction materials) is slated for a still larger increase, 5.0–5.1 percent. Machinebuilding itself has an output target of about 7.4 percent, with the five-year total investment in machinebuilding planned to rise by 80 percent over the 1981–85 volume, compared to a 24 percent increase for total investment.[6]

For the first time we now have an official clue to the military-civilian breakdown of investment in machinebuilding (hereafter MB).[7] At the June 1985 S&T conference, Gorbachev said that civil-

[4] At the 27th Party Congress, Ryzhkov also contented himself with one sentence, assuring "full provision of the Soviet armed forces with everything necessary for defense of the motherland." *Pravda*, March 4, 1986.

[5] The 1986 "defense" budget was maintained at the 1985 level and the 1987 allocation is to increase by 1 percent, but the significance of these actions remains murky.

[6] Some analysts have drawn attention to the planned rise in the share of the accumulation fund in national income, from 25.9 percent in 1985 to 27.6 percent in 1990 (according to Ryzhkov at the Supreme Soviet in June 1986). While it may be true that procurement is to be found in the accumulation fund, if it is in fact counted in published national income data, accumulation is dominated by net investment in fixed working capital. Given the more rapid rate of growth of investment compared to national income and the determination to cut the volume of unfinished construction, it would not be surprising to have a substantial increase in the share of net fixed investment. This must have been even more marked in 1986 when the original annual plan called for an increase of total investment of 7.6 percent (*Pravda*, November 27, 1985), which was subsequently raised to 8.4 percent; actual investment rose 8 percent (*Pravda*, January 18, 1987).

[7] The Soviets distinguish metalworking and machinery repair from machinebuilding proper, all of which together are called machinebuilding and metalworking. Often, however, "machinebuilding" is used loosely to designate the whole complex.

ian MB in the 11th FYP period (1981–85) accounted for only 5 percent of all productive investment. Since both the latter figure and investment in all MB are known (Narkhoz 1985, pp. 365, 368), the share of military MB in 1981–85 can be calculated as about 42 billion rubles (BR), 58 percent of total MB investment of 73 BR. There are two immediate pitfalls in this calculation, both related to the different organizational units of accounting in the statistics compiled by TsSU, the Central Statistical Administration. Did Gorbachev intend a ministerial or branch count of civilian MB investment? [8] The former would represent investment in the 11 primarily civilian-oriented MB ministries,[9] whereas the latter would count investment by all enterprises whose output was primarily civilian. Since this is a difficult distinction to make, one would guess that Gorbachev's figure referred to ministries. The other question is whether total MB involvement is a ministerial or branch summation. The answer is not entirely clear and the calculated military share of MB investment could be off considerably.

Assume, however, that 60 percent is approximately correct as this ratio. What of the 12th FYP? Here there are other mysteries. The 5-year total investment in MB was scheduled to rise by 80 percent over the 1981–85 volume.[10] Since 80–100 percent is the figure Gorbachev used in June 1985 to discuss the growth necessary for civilian MB, one would be inclined to associate the 80 percent FYP growth target with civilian MB.[11] Ryzhkov declared that the 12th FYP volume of investment in MB would come to 63 billion rubles. This figure could hardly be total MB if the sum of investment in civilian and military MB in 1981–85 was 73 BR. If 63 BR refers only to civilian MB investment, it is more than double the 1981–85 figure of 31 BR, rather than 80 percent larger. Does the 80 percent growth target then refer to the sum of civilian and military MB? If so, the 12th FYP total would be 131 BR and the military MB share would be 68 BR or 52 percent, down from the 58 percent share in 1981–85. The growth target for military MB investment would be 62 percent, but would still imply a 1990 level perhaps twice as large as in 1985. In contrast, if Ryzhkov's 63 BR target really is all

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[8] Soviet production data may be compiled and reported in three different distributions—by ministry, branch and commodity classifications. Thus, the value of machinebuilding (MB) output in a ministerial classification will include any and all output of the 20 MB ministries and will exclude the MB of non-MB ministries; in the branch classification, MB produced by enterprises whose major production is MB (whether or not they are administered by a MB ministry) will be counted, but so will all other output of these enterprises, and the MB production of non-MB enterprises (including those in MB ministries) will be excluded; only the commodity classification provides a count of all MB and only MB output, no matter where produced. (Commodity value counts are generally associated with input-output tables and are therefore likely to be compiled only intermittently). This characteristic of Soviet statistics has confused a number of Western attempts at reconstructing Soviet production accounts (particularly, the efforts to derive residual values of Soviet hardware production).

[9] That is, other than the Ministries of Aviation Industry, Communication Equipment, Defense Industry, Electronics, General Machine Building, Machine Building, Medium Machine Building, Radio Industry, and Shipbuilding Industry.

[10] It is assumed that the 12th FYP investment figures refer to ministerial totals. If they do not, the uncertainties noted below are compounded.

[11] The target for MB investment in the 1986 budget is also stated explicitly to apply to civilian MB. Although Gosplan chairman Talyzin did not identify the scope of the same investment target in his speech on the 1986 plan on the same day (*Pravda*, November 27, 1985), *Vestnik statistiki*, 1986, No. 2, p. 50, declares that the target applies to 11 machinebuilding ministries. Both this source and the budget speech introduce another complication, however, by linking the civilian machinery investment target to the goal for MB output, 6.6 percent: does this also refer to civilian MB?

investment in MB, an 80 percent increase of the civilian component would bring it to 56 BR, allowing only 7 BR for military MB *for the five years*, less than the probable spending in 1985 alone. This would, of course, represent a drastic, unprecedented slash in the military's share of MB investment and seems distinctly unlikely. But perhaps other interpretations of the scope and meaning of these figures are possible.

The planned rate of growth of MB output was noted previously as 7.4 percent per year (43 percent over 5 years). The military share of total MB output is considerable but the Western estimates differ widely.[12] The published plan does not indicate the growth targets for the civilian or military components. Thus, it is not possible to replicate the planned growth of military MB.

Unfortunately, therefore, these efforts to unravel the military industrial mysteries of the 12th FYP are inconclusive. Looking at the plan's general targets, the rapid rates of planned increase in output and investment could mean considerable expansion of the military sector.[13] On the other hand, the spirit of the plan's industrial provisions is restructuring of the material, technical and human factor foundations. In MB the emphasis is chiefly qualitative—transforming the structure of output, technical standards, and technical progress. Again, this does not preclude rapid growth of military machinery, but the published draft's language and spirit seems to look rather to reequipping heavy industry as rapidly as possible.

Finally, the 12th FYP provides for spirited growth of annual operating outlays on "science", about 5.9 percent per year (one-third in five years), and of the 5-year volume of investment in science, 70 percent. Roughly half of all Soviet outlays on "science" are believed to be devoted to military R&D. If these targets are approximately global in scope, there might be considerable room within them for expansion of the military component.

Gorbachev's Views

From his first days in office as general secretary—indeed, even before, during Chernenko's last months (e.g., in *Pravda*, December 11, 1984)—Gorbachev has made clear his driving concern to revitalize the Soviet economy and to transform its character. In his multiple restatements of this position, from various rostrums and in various forms, Gorbachev has also drawn attention to the historical significance of succeeding or failing in that task. In the April 1985 Party Pleunum (*Pravda*, April 24, 1985), he said: "The country's

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[12] Bond and Levine (1982, pp. 301-304), estimated 16 percent for just military hardware (i.e., excluding durables commonly used in civilian activities) in 1980 and projected 17-22 percent in 1985; DIA claimed the share was 59 percent in 1982 (Allocation 1983, p. 7); Jan Vanous (*Washington Post*, August 17, 1986), used the figure of 44 percent for 1985; while CIA has the lowest estimate, about one-quarter "in recent years" (Allocation 1985, p. 6). Presumably the chief reason for the considerable divergence is different methodologies. Bond and Levine "residualized" gross value of machinebuilding output statistics. DIA's figure undoubtedly derives from a calculation of the output of ministerial machinebuilding. CIA's approach has not been published.

[13] If investment in military MB is scheduled to roughly double between 1985 and 1990, military MB output would presumably increase rapidly too, although much of the investment could be slated for modernization rather than expansion of capacity. The polar case of sharp absolute decline in military MB investment would have to mean a freezing of military MB output at least, more likely, a decline in projected output.

historical destiny and the position of socialism in today's world depends in large part on how we handle matters from now on". In Leningrad a month later (Radio Moscow, May 21, 1985; FBIS SOV, May 22, 1985, p. R4) he told his listeners that the USSR could not indulge in the luxury of relaxing into a quiet life, because "history, if nothing else, is not giving us an opportunity". At the June 1986 Party Plenum (*Pravda*, June 17, 1986), he defined the *political* task of the 1986–90 period—

> to restructure our economy, create a modern material and technical base to ensure the faster development of Soviet society, and a solution of major social tasks and reliable defense of the country. Time will not wait for us. Everything that we have planned must be done in time, for the point at issue is the might and prosperity of our power, the positions of socialism in the international arena and the consolidation of peace throughout the world.

At the 26th Party Congress he spoke of the need for radical reform of the society. By the middle of 1986 he was using the term "revolutionary" for the scale of change needed. In January 1987 he combined the two (Radio Moscow, January 27, 1987; FBIS SOV, January 28, 1987, p. R9), demanding—

> a radical turn and measures of a revolutionary character. As we talk about reorganization and associated processes of deepgoing democratization of society, we mean truly revolutionary and comprehensive transformations in society.
>
> We need to make this decisive turn because we just don't have the choice of another way. We must not retreat and we don't have anywhere to retreat to.

At the same time, his references to the armed forces, their achievements and nurturing, and to the question of the military budget have been brief and grudging. He has denounced imperialism and American appetites for military superiority, but on military resource allocation he has rarely gone beyond the blandness of "We will continue to spare no effort to give the USSR Armed Forces everything for the reliable defense of our fatherland and its allies, so that no one can take us unawares" (*Pravda*, April 24, 1985). He has pursued a militant arms control policy and in the process pushed the Brezhnev "Tula line" into new territory, where "concern for national security now demands the most scrupulous considerations of the security interests of other states." (Radio Moscow, June 6, 1986; FBIS SOV, June 9, 1986, p. G2).[14]

A more concrete indication of his commitment to economic over military development is the increasing conscription of defense industry to aid civilian production. This is an idea whose postwar origins go back to the brief Malenkov regime in 1953–54, but they are most prominently associated with Brezhnev's declaration at the 24th Party Congress in 1971 (Cooper 1986, p. 34) Gorbachev is carrying on with possibly greater determination. The plans for modernization and acceleration of high-technology MB output would be completely infeasible without the extended cooperation of defense industry. For example, computers are produced by the VPK-controlled Ministries of the Radio Industry, Electronics Industry, and Communications Equipment Industry (Cooper 1986, p. 37); a high proportion of all electronics used throughout the economy comes from the Ministry of Electronics Industry; and so on. At the June

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[14] Rumors circulated in Moscow in the summer of 1985 that Gorbachev warned the regional military leaders assembled in Minsk in July that he was going to cut the military budget. See, e.g., Herspring 1986, p. 311.

1985 S&T conference, he announced his intention to make full use of defense industry experience. The guidelines of the 12th FYP demand a significant increase in consumer durable production from defense industry. Presenting the draft of the plan before the Supreme Soviet in June 1986, Ryzhkov declared that all MB, including its military component would be enlisted to expand light industry output. Lev Zaikov, Politburo member and probably the CC secretary in charge of the military economic sector, declared (*Pravda*, June 29, 1986):

> It has been decided that the military branches of industry will not only take an active part in the production of civilian and nationally needed goods, but also combine it with the technical reequipping of light and food industries, public services and trade.

Gorbachev expressed the same idea more colorfully three months later (Radio Moscow, September 19, 1986; FBIS SOV, September 22, 1986, pp. R3-4):

> . . . everyone has got used to being able to sell off any old machinery to agriculture, just junk, and the attitude is the same for the food industry, and even for light industry. Thus we have decided to instruct the defense ministries to help light industry, the food industry and the rural sector to resolve certain issues, to get rid of bottlenecks. They tell us, listen, it is easier to deal with defense matters and go into space than to improve the technical level of looms, or to make machinery for the food industry. It seems you need enormous qualifications and real design talent, you see, to deal with these tasks.

Those qualifications were found in defense industry. "We have all been brought up to respect defense and heavy industry." Now let their talents be applied to the solution of the problem of reequipping consumer goods industry.

Gorbachev is a man in a hurry to reconstruct the political, economic and social foundations of the society. It is true that the 12th FYP, and Gorbachev in speaking about it, propose simultaneously to raise consumer welfare, accelerate economic growth and strengthen defense. However, in the tens of thousands of words that have issued from his mouth over the past two years, and in the actions of the regime accompanying them, it is apparent that his top priority is economic growth, followed by consumer welfare; defense, at least in terms of the attention paid it, is a distant third.

Soviet Military Views on the Gorbachev Program

Given the conflict between the high command, led by Marshal Ogarkov, and the Party during Brezhnev's last years and the 28-month interregnum (Azrael 1987), the views of the Soviet military on Gorbachev's development program could be an important barometer of civil-military relations, as well as an indicator of the state of the struggle over the military budget. It appears that military grumbling over resource allocation has virtually disappeared from the Soviet media. Perhaps this is evidence of support for the Gorbachev program. There are plausible reasons why the military may have been won over, at least for the time being, but there is an inevitable tension in that support that may erode the understanding over time.

On one plank of the Gorbachev program, there is no reason to doubt the genuineness of military enthusiasm. The campaign to raise the level of discipline from the factory bench to the minister's

cabinet must have unqualified military approval. Discipline is a favorite theme of military writing, and commanders cannot but rejoice when the civilian leader attempts to root out the corruption, lethargy and alienation that have taken hold in the society over the course of decades. This was clearly the military reaction to the earlier incarnation of the discipline campaign, under Andropov. Marshal Petrov (1983) the chief of the ground forces, greeted it enthusiastically: the instruction "to launch an all-around campaign to strengthen labor discipline is especially close to the heart of us military people." The effects on the quality of recruits is hinted at in the following carefully crafted passage from a recent article in *Krasnaia zvezda* (Luzherenko 1987):

> When discussing discipline, we are aware that its vehicle is man. And man is changing. The people coming into the Army today are not the same as those of 30, 20, and 10 years ago: they are better educated and have broader technical and cultural horizons while at the same time they are less prepared for the difficulties of service and less experienced in the practicalities of life. This must be taken into account by officers, warrant officers, and ensigns in work to train and educate subordinates.

Further, the author writes:

> Our Army is not divorced from the people but is very closely associated with it, and all the processes taking place in the country are reflected in the Army. From this standpoint, the measures taken by the party to enhance the level of discipline and organization in society exert both a direct and indirect influence on strengthening discipline in the Army and Navy while, on the other hand, the efforts of civilians, political organs, staffs, and party and Komsomol organizations to instill a spirit of high discipline in Soviet servicemen exert a tangible and beneficial influence on the state of discipline in labor collectives joined by military servicemen on their discharge into the reserves.

Thus, the armed forces and the Party are partners in an effort that promotes mutual interests. Marshal Ogarkov, who often worried in print about Soviet youth and the strength of their patriotism, is probably also applauding.

On issues of resource allocation, however, it is hard to find "interesting" excerpts. Marshal Sokolov, the defense minister from 1985 to mid-1987, "had little to say on issues of major importance to the Soviet military" in the six years before he took that office and "appears to be a lightweight in the Soviet military hierarchy" (Herspring 1986a, p. 299). Herspring (1986b, p. 531) observes that Marshal Akhromeyev, the present chief of the General Staff, does not discuss the issue of the relation of the economy to the military effort, except to note its importance. His position on the adequacy of the military budget is to restate the Party line that "the USSR armed forces have at their disposal every thing needed to successfully carry out the tasks entrusted to them."

Denunciations of U.S. security policy are, of course, abundant in Soviet military writings; these denunciations center on the refusal of the Reagan administration to accept the Soviet Union's arms control initiatives, thereby endangering international security.[15] "In these conditions," declares Army General Shabanov (1986), deputy defense minister in charge of armaments, "the CPSU and the Soviet government are forced to take the necessary and, frank-

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[15] For discussion of possible misgivings on the part of the high command with regard to Gorbachev's arms control ventures, see Herspring 1986a, pp. 303–307.

ly, obligatory measures to strengthen the country's defense capability and prevent military superiority on the part of the United States and the NATO bloc over the Sovet Union and the Warsaw Pact." However, Shabanov weakens the force of that statement by first referring to the new Party Program, "which defines extremely clearly our party's policy in the defense sphere." [16] Then he declares: "the flexibility of the socialist economy and its ability to restructure itself and develop in accordance with the developing situation enables us to adopt prompt measures to restore the strategic parity if it is violated by militarist circles."

Herspring (1986a, p. 313) "suspects that the military is not fully satisfied with its share of the budget," but he draws the conclusion from rather fragile evidence: ambiguous language in *Krasnaia zvezda* editorials on the nature of the imperialist threat and nuances of differences in statements by major Party leaders on the Party's concern for maintaining defense expenditures at an appropriate level. Herspring may still be right, but a strong argument can be made that the military have made an accommodation—perhaps grudging—with the Gorbachev program. That acceptance would be based on a consensus identification of the long term threat to Soviet security and belief that the Gorbachev program held short term risks but also long term promise of significantly improving the Soviet military position.

In the Victory Day interview in May 1984, Ogarkov had warned of the revolution in conventional technology that was in the offing and in which the United States was becoming fully engaged. By that time the threat of strategic defense in space had been added to the threat of information-based technologies of conventional warfare on land, sea and in the air, about which Ogarkov had written for a number of years. It was, however, in just these technologies that the Soviet Union lagged behind the West most conspicuously. Ogarkov was not alone among the Soviet military in fearing that the pace of technological change was accelerating while the ability of the USSR to keep up, burdened as it was by a backward economy under multiple strains, was seriously in doubt.

In effect the Soviet Union finds itself racing in an outer lane of a circular track while its adversary has the advantage of an inner lane. The price of technical backwardness is the necessity to run harder, perhaps increasingly so. To escape this trap, the USSR must attempt to get closer to the hinge of the swing, to change lanes while at least remaining abreast of its competitor. On the running track this may not appear so difficult, but in the arena of arms competition the effort required is strenuous. The USSR must slow U.S. development or accelerate Soviet development or both. SALT probably appeared to Soviet leaders a means of doing the first, but that effort was nullified by the collapse of détente. Because the pace of the military-technical revolution has speeded up in the late 1970's and first half of the 1980's, Moscow perceives a need to accelerate its own effort, while making renewed attempts to constrain American and Western European progress.

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[16] Presumably Shabanov refers to Section IIIC of Part 2 of the Program, "The strengthening of the Armed Forces and the Defense Potential of the Soviet Union," which is definitely not a manifesto for acceleration of military spending.

The foreign politics of constraint are reasonably clear—intensive arms control diplomacy is its spearhead, supported by other efforts to distance Western Europe from the United States. How are the military economics of acceleration being decided? Immediate counters, meaning a stepup in procurement and in the development of weapons technology already well explored, would constitute a major threat to the civilian modernization program. The alternative is development of the infrastructure that will make possible more sophisticated weaponry further down the road. Perhaps the most important point to be raised is that the priority areas of machinebuilding now being emphasized are of dual significance to both civil and military industry. The point is nicely set forth by Major General Yasyukov (1985, p. 20):

> Today it is difficult to overestimate the party's concern for cardinal acceleration of scientific-technical progress in the matter of strengthening military-economic potential. After all, the leading directions of scientific-technical progress—the further, priority development of machine-building, particularly machine-tool building, robot technology, computer technology, instrument-making, and electronics—are simultaneously the basic catalysts of military-technical progress.
>
> Today what is required for serial production of contemporary weapons and the newest combat equipment is not conventional or ordinary equipment but the most modern and frequently unique equipment, including new in principle instruments, numerically-controlled machine-tools, robot equipment, latest generation computers, and flexible manufacturing systems. In other words, the present stage of the military-technical competition which has been imposed on us by imperialism requires a high level of development of those branches of industry with the best prospects, of the most modern technology, and of a highly qualified work force.

A year later, General Yasyukov (1986, p. V2) reiterated the argument: "The backbone, the load-bearing wall of our country's defense capability is the Soviet economy." Therefore the program of "accelerated development, intensification and increasing the efficiency of the economy objectively offers new potential for military building, too. The investment in the core high-technology branches of machinebuilding and other sectors which determine scientific and technical progress" enables the USSR "to react promptly to imperialist circles' attempts to break the military-strategic parity in their own favor."

Yasyukov is a political officer and may not be representative of the "real" military. Nevertheless, his argument may persuade. Over the preceding decade, Soviet growth across the board had slowed to a crawl. Resource allocation choices at the macrolevel, among the chief end uses of the national output, had become painful and generated party-military conflict. Shortages and bottlenecks, endemic in the civil sector, had spilled over to military production. Above all, the perennial problem of technical progress had become acute. Gorbachev's program would confront all of these issues. It is a plausible reading of the sparse evidence on military views but of the abundant evidence on Soviet difficulties to suggest that a tradeoff of short term constraints on military production and procurement for increased longer term potential, especially in the quality dimensions, would have been accepted by the Soviet high command.

The case would be strengthened by adoption of the U.S. intelligence community view (Allocation 1985, pp. 51–52) that—

> almost all of the production capacity required to support force modernization over the next six years or so is already in place. Our calculations suggest that virtually

no additional investment in plant and equipment is needed to manufacture the military hardware that we believe will be in production in 1986–88 and that most of the capacity required to turn out the military equipment projected to be in production in the early 1990s is already available. Thus, military production would not be constrained in the near term by a reallocation of new fixed investment in the form of civilian machinery and other priority sectors.

CIA and DIA do see room for civil-military competition over supplies of skilled labor, components and materials. For example, skilled programmers are badly needed for modernization of civilian machinery production and in defense production too but are in short supply; the same is true of microelectronic materials and components; high-quality steel and energy will also be in great demand (Allocation 1985, pp. 52–53).

Nevertheless, the Director of Soviet Analysis, CIA, believed that (Allocation 1985, p. 119)—

the question for the next few years is, how much of the capacity of the machine building section . . . will be used to build new machines, as opposed to how much of that capacity will produce weapons?

Some of the best quality machinery in precisely the areas of greatest development priority now—for example, flexible manufacturing systems and computer-operated machine tools—were allocated to military industry in the modernization effort of the 1970's. It will be a test of the contemporary status of the defense sector whether such critical resources are not diverted for the use of civilian machinery development as the pressures for plan fulfillment mount. Obviously, in the event of such diversion, the strains with the military leadership could be revived.

Conclusions

A Moscow wit in the early months of Gorbachev's accession ventured that Marshal Ustinov had performed two great services for Gorbachev—removing Ogarkov from the post of chief of the General Staff and passing away himself. The colorless Sokolov partially replaced Ustinov,[17] who had known Stalin and served the government, the Party, and the army, for over four decades. In place of the charismatic Ogarkov, there came the capable but far less flamboyant Akhromeyev. Thus Gorbachev was able to launch the campaign for civil economic acceleration and modernization without the threat of interference from dynamic, independent military chieftains.

Ogarkov remains sidelined from the center of political action but he would be justified in feeling partially vindicated. More than any other military leader he proclaimed the revolution of the new conventional military technology based on electronics, computers and information science. Under Brezhnev and in the interregnum, only the first short steps were taken to develop Soviet capability in this area. The rhetoric of Gorbachev's program focuses on civilian modernization, but the civil-military duality is apparent and underscored by some military writers. It is, therefore, the Gorbachev program that may bring the Soviet Union to the threshold of exploiting the possibilities envisioned by Ogarkov.

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[17] Sokolov took over the defense ministry but was only awarded a candidate seat in the Politburo.

"Politics is usually about relatively small choices on the margin of a much larger, untouchable whole," John Parker (forthcoming) has aptly noted. In a decade of muddle, Ogarkov refused to play the game in that fashion and was eventually removed from the central arena of politics. Even from the sidelines, he may be gratified to see the end of that period of muddling through and the inauguration of a reformist politics, one that reopens the formerly "untouchable whole". Choices made at the margin are politically less stressful when key sectors of the economy and society are developing in healthy conjuncture. Gorbachev and his supporters often make reference to the lessons of NEP, but the Soviet situation in the mid-1980's bore intriguing resemblances to the picture drawn by the left industrializers in the late 1920's. Under the existing arrangements, the economy was beginning to stagnate. Unmet needs of consumption, investment, and defense could not be satisfied by marginal reallocations and that failure was threatening the state's external position, the society's future and the security of the regime's foundation. To resolve one of these problems required a simultaneous attack on all; growth acceleration and sweeping modernization had to be substituted for resource shifts at the margin. This was the strategic essence of Gorbachev's vision; the rest was tactics.

In this abstract form and in principle, the military should have no problem with the Party's economic strategy, particularly given the enormous weapon inventories accumulated over the past decade or more. But the bargain, implicit or explicit, is likely to hold only as long as the conditions of the understanding are fulfilled, that the sacrifice of current security interests does not become unexpectedly large and that the bright promise of future military potential appears realizable. The General Staff might see the former condition violated if military production and procurement had to be cut back significantly to accommodate civilian needs or if Gorbachev were unable to constrain the growth of Western military power. Slippages in the economic modernization program or acceleration in military technical progress in the West would erode the second condition. One would guess that Gorbachev's authority and possibly even his chances of political survival could also be undermined in the process.

There is another dimension of the Gorbachev economic program, military-economic planning and decisionmaking, that may make the high command uneasy, because it seems to accelerate processes that began under Brezhnev. Elsewhere (Becker 1986a, pp. 49–50) I suggested that the four chief foundations of military-economic organization in the heyday of Soviet military development were being undermined over time. *Priority in resource allocation* had insured high quality resource inputs and helped insulate the defense sector against the vagaries of civil sector operation. However, in the last half of the 1970's the growth of defense sector outputs and inputs turned downward; major "target programs", dealing with complexes of economic branches (agro-industrial, energy, etc.) became line items in the national plan; a number of experienced, high-level defense industry managers were shifted to top positions in the civil economy; the military production sector was unable to seal itself off completely from the bottlenecks and shortages that became a

more serious problem of the civilian branches. The principle of *continuity of funding* was at least bent by the prolonged slowdown of Soviet defense spending. Investment in military industry also suffered from the retardation of overall investment growth. The *close tie-in of military R&D with military industry* has endured, but the adequacy of the military science and technology base came under sharp criticism, and the production infrastructure, despite the modernization efforts of the 1970's, is viewed as lagging far behind that of the West. Only *centralized control over the military development-production process* remains unchallenged and enduring. Even here, however, it is interesting to observe that by the erection of such bodies as the coordinating bureaus for machinery and the fuel energy complex under the Presidium of the USSR Council of Ministers, the regime seeks to extend the benefits of the demanding customer, so central to the military-economic model, to important civilian sectors. By the same token, however, such action continues the process of diffusion of priority that is now accentuated by Gorbachev's promotion of high-technology machinebuilding.

We have come to appreciate that even in the first decade of the Brezhnev period the civil and military branches of Soviet industry were separated not by a Chinese wall but by a more loosely-constructed barrier. The movement of resources and knowhow tended to be in one direction, from civilian to military, and was effectively controlled by the institutions of military-economic decisionmaking, particularly the VPK. Nevertheless, military machinery ministries produced substantial volumes of civilian goods; the input-output relationship between the producers of military end items and their suppliers became more complex and more wide-ranging; and the VPK ministries came under pressure from the early 1970's to cooperate in raising efficiency and quality in civilian industry. Now Gorbachev has brought extraordinary emphasis to the group of dual-use, high-technology machinery and has intensified the pressure on military industry to share the burden of tasks in civilian industry. The distinctions between military and civil industry are likely to become fuzzier, the barriers between the sectors turning into more permeable membranes. The function of the VPK may become less that of overseeing a definable group of industrial branches than of coordinating the stages of development and production sustaining a set of final military goods and services. In the process, there is likely to be an increasing problem of "turf" between the VPK and the civilian machinebuilding bureau. Thus the erosion of military priority and the requirements to cope with the "revolution" in military technology can feed back upon each other.

The Gorbachev machinebuilding modernization effort may be able to advance the production technology of military industry and the capital infrastructure of military R&D. But two caveats appear worthy of mention. The current program does not appear to plan for major reliance on imported Western technology. There is no public evidence on the volume of resources and attention that are to be devoted to the covert programs of securing Western technology, and perhaps they will be maintained or even increased. However, to this point Gorbachev displays considerable ambivalence on the subject of overt imports of Western technology, largely out of fear of political and economic dependence (Becker 1986b). Whether

this attitude will change remains to be seen: it may be especially stressed if "autonomous" modernization should appear to lag substantially behind current projections.

A second consideration concerns military R&D. A successful machinery modernization program may, as noted, have important impact on the capital structure of military R&D, but it is unlikely to do much for the R&D process itself. For someone like Ogarkov, who was concerned about the rapid obsolescence of weapons under the acceleration of the "scientific-technical revolution", the orderly but slow-paced process of weapons development and acquisition may have seemed even more a problem than the level of budget support. Here Gorbachev's reforms of enterprise organization incentives will be critical. So far, by Soviet admission, little effective change has been achieved. Again, it will take some time before it will be apparent how successful the effort can be. But unless considerable progress is made, Ogarkov's fears of a dynamic West outpacing the clumsy Soviet machine could be realized.

Two years, then, into Gorbachev's time at the Soviet helm, one may postulate that on the issue of resource allocation army and Party have a modus vivendi erected on the promise of Gorbachev's internal and external policy. But the agreement does involve a continued acceptance of short term risks that in some military views have been mounting for close to a decade. Gorbachev's maneuver space is therefore not unlimited, and an inability to make good on the promise could well rekindle the embers of Party-military conflict.

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TECHNOLOGY TRANSFER BETWEEN MILITARY AND CIVILIAN MINISTRIES

By Julian Cooper*

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Summary

The Gorbachev leadership is attempting to engage the defense sector in the modernization of the civilian economy. This chapter explores some of the agencies and mechanisms involved in the transfer of technology between military and civilian ministries and provides specific examples of transfer activity. It is concluded that such inter-sectoral transfers may make a worthwhile, but not dramatic, contribution to the modernization drive.

Policy and the Transfer Problem**

Speaking at the June 1985 Central Committee conference on scientific and technical progress, General Secretary Mikhail Gorbachev declared that ". . . in general the experience of the defense branches must be used in full measure. We have begun this work.

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It has to be continued actively."[1] Later in the year, writing in *Pravda*, the eminent control theory specialist, Academician V.A. Trapeznikov, called for the widescale use in the economy of the experience of the defense sector, especially in the field of quality control.[2] The well-known economist, Academician Oleg Bogomolov, in an interview with a Hungarian journal, called for more extensive technology transfer from the military sector to the civilian economy.[3] Finally, in the summer of 1986, L.N. Zaikov, Central Committee secretary with responsibility for the defense industry, revealed that "It has been decided not only to get the defense branches of industry more actively working for the output of civilian products and consumer goods, but also to engage them in the technical reequipment of the light and food industries, public catering, and the trade sector."[4] This policy commitment to harnessing the experience of the defense sector to the civilian economy is not new, but does appear to have gained strength in the recent period. As Zaikov's statement indicates, a definite decision has been taken to step up the transfer process. The last occasion when there is evidence that a similar decision was taken was fifteen years ago at the time of the 24th Party Congress in 1971.

Until recently the predominant view in the West has been that there is very little technology transfer from the military sector to the civilian economy in the Soviet Union. Campbell in his pioneering work identified some spillovers of management innovations, but found little evidence of transfers of innovations in processes, materials and hardware.[5] This finding has been endorsed by the emigre writer Agursky, who on the basis of his own personal experience concluded that transfers of hardware are rare and that the flow is almost entirely the other way, from civilian industry to military.[6] Based on the experience of the 1960's, these conclusions accord well with a widely met image of the Soviet defense industry as representing a quite distinct sector of the economy, separated from civilian industry by an almost impenetrable barrier of secrecy.

If the defense sector is defined as that part of Soviet industry administered by the nine defense industry ministries, then this traditional image must be regarded as over simplified. In the first place, the defense sector receives materials, components and equipment from enterprises of nominally civilian ministries, and the latter also supplies some military end products, for example, armoured

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[1] M.S. Gorbachev, *Izbrannye rechi i stat'i*, Moscow, Politizdat, 1985, p. 119 and BBC, Summary of World Broadcasts, SU/7976/C/8 13 June 1985. The first source gives only the first sentence quoted. The entire quotation was omitted from the Pravda version of the speech (12 June 1985).

[2] *Pravda*, 2 October 1985.

[3] *Heti Világgazdaság*, 22 February 1986, p. 12. Bogomolov said "In the Soviet Union the defense tasks of industry tie up considerable effort and resources, especially skilled personnel, scientists and engineers. This can be explained by the fact that there is no task more important than the security of our state . . . But the defense industry is only one part of the economy, and not even the most important part. If the economy as a whole is not on a sound basis, then the branches serving defense cannot be developed either. On the other hand, the military sector by its technical results must help the other industrial branches more rapidly and extensively than until now." I am grateful to Dr. Margit Nielson for supplying this reference.

[4] *Pravda*, 29 June 1986 (Speech in Irkutsk).

[5] Robert Campbell, "Management Spillovers from Soviet Space and Military Programmes," *Soviet Studies*, Vol. 23, No. 4, April 1972, p 606.

[6] M. Agursky, *The Research Institute of Machine-Building Technology*, Soviet Institutions Series, No. 8, The Hebrew University of Jerusalem, September 1976, pp. 56 ff. (In Russian).

vehicles. Secondly, enterprises of the defense industry ministries produce civilian goods on a substantial scale and in doing so have to maintain relations with many civilian ministries and organisations. Furthermore, they also produce a wide range of materials and equipment and while much of this output satisfies the requirements of the defense sector itself, a certain proportion is supplied to customers in the civilian economy. This can be illustrated by the example of the Ministry of the Defense Industry. Besides equipment for the ground forces, enterprises of this ministry produce rail freight cars, heavy-duty tractors, passenger cars, motorcycles, industrial optical equipment, lasers, cameras, equipment for the oil, chemical and nuclear power industries, agricultural machinery, medical equipment, and a wide range of consumer goods. This ministry also has quite substantial steel making capacity and manufactures machine tools, industrial robots and other production equipment.[7] Thus while it is true that the defense sector has some special features distinguishing it from its civilian counterpart, the separation of the two sectors is relative, not absolute, and the fact that there are well-established inter-relations between the sectors creates possibilities for transfers of technology to the benefit of the civilian economy.

The definition of technology transfer employed here is a broad one, wider than the usual understanding of "spinoff." We are concerned with any transfer to the civilian economy of a technological innovation arising within the defense sector. Thus the innovation transferred may not necessarily relate directly to the development or production of weapons or space technology. In the Soviet economy transfers of technology between any two industrial ministries, or cooperative work by organisations of different ministries on particular new technology projects, are frequently attended by difficulties arising from the strongly expressed "verticalism" and departmentalism of the organisational and administrative structures characteristic of the industrial sector. In the absence of market relations horizontal links between organisations of different ministries are weakly developed, and in these circumstances the mediation of special agencies and mechanisms is often required for transfers and cooperation to be successful. In the case of transfers from the military sector these problems characteristic of the economy in general are exacerbated by the sector's culture of secrecy and exclusiveness, so that the question of mediating agencies and mechanisms acquires even greater significance.

The specific organisational features of the Soviet defense industry condition the possible forms of technology transfer between military and civilian ministries. These forms include (a) transfers between military and civilian production within a single defense industry ministry; (b) direct transfers between the military production of defense industry ministries and the civilian production of civilian ministries; and (c) transfers between the civilian production of defense industry ministries and civilian ministries. In principle, form (a) should be the simplest form of transfer insofar as it

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[7] See J. Cooper, "The Civilian Production of the Soviet Defence Industry" in R. Amann and J. Cooper (eds.), *Technical Progress and Soviet Economic Development*, Oxford, Blackwell, 1986, pp. 34–9.

takes place within a single ministry. Military and civilian activities often take place in parallel within one and the same enterprise or association, and draw on common ministerial R&D facilities, including central production technology institutes. Thus one might expect to find technology transfers (in both directions) between the tank and railcar building of the vast Nizhnii-Tagil "Uralvagonzavod" works of the Ministry of the Defense Industry, or between the military precision instrument making and watch production of the Kuibyshev "Zavod im.Maslennikova" association of the Ministry of Machinebuilding. For this form of intra-ministerial transfer considerations of secrecy are by no means absent, but are probably more easily handled than for direct inter-ministerial transfers of type (b). In principle, one would expect this second form of transfer to be the most difficult insofar as it involves both secrecy and the problem of overcoming organisational barriers between ministries. For the third form (c) considerations of secrecy are probably less acute and for this reason one might expect to find cases where the civilian activities of defense industry ministries serve as mediating links between the two sectors, offering possibilities of a two-stage transfer process: first form (a) within a given ministry, and then form (c) between ministries.

Transfer Agencies and Mechanisms

(1) Scientific and Technical Information Agencies

Given the explicitly stated policy commitment to transferring experience and technology from the defense industry to the civilian economy, it is worth considering some of the agencies and mechanisms involved in mediation between the two sectors. Some of the mechanisms are concerned with the dissemination of information about technological innovations in the defense sector; others facilitate direct contact and more active forms of cooperation. In the following discussion the mechanisms have been ordered according to an approximate "informational"/"active" ranking, starting with the former.

Each of the nine defense industry ministries has its own central branch scientific and technical information institute. Some are mentioned quite frequently in the Soviet press and technical literature, for example, the "Elektronika" institute of the Ministry of the Electronics Industry; others are mentioned only in more specialised sources. Examples of the latter include "Ekos" of the communications equipment ministry, the Central Research Institute of Scientific and Technical Information (TsNIINTI) of the Ministry of Machinebuilding and "Volna" of the aviation industry. All are located in Moscow, with the exception of the shipbuilding industry's Central Research Institute "Rumb" in Leningrad. These institutes not only service the informational needs of the branches themselves, but also provide information on technologies developed by organisations within the ministries but available for application elsewhere in the economy. Some of these technologies are publicised by the journal *Tekhnika i Nauka,* the organ of the All-Union Council of the Scientific and Technical Societies, which indicates the relevant information agencies from which further details can be obtained. Examples include an installation for making animal

feed from woodpulp (TsNII "Rumb"), a robotised assembly system (TsNTI "Volna"), and a portable unit for spraying protective coatings (TsNIINTI).[8] Catalogues of industrial equipment may also cite these agencies as sources of information available to interested organisations.[9]

In addition to the ministerial central institutes, information on technologies available from the military sector is provided by the All-Union Research Institute of Inter-branch Information (VIMI). This organisation, the administrative affiliation of which has not been revealed, has become known in the West because of its role in processing and disseminating military-related information obtained in the West, including material acquired by covert means.[10] But VIMI also provides information on technologies developed by domestic organisations and it is possible that it substitutes for the ministerial agencies when the sources of the technologies concerned are particularly sensitive from a security point of view.[11] Soviet works have described VIMI's role in providing technical information for the automobile industry: in 1974 the industry introduced 212 measures publicised by information sheets issued by VIMI, compared with 61 measures derived from information sheets supplied by the industry's own central information institute.[12] Thus despite the known deficiencies of the Soviet scientific and technical information system, it does appear to play a role in facilitating technology transfer from the defense sector to the civilian economy.

(II) THE PRESS, TECHNICAL JOURNALS AND BOOKS

Soviet national and local newspapers quite regularly feature the experience of defense industry enterprises, although the ministerial affiliation of the exterprises concerned is rarely mentioned and readers in both the USSR and the West may often be unaware that the good practices described pertain to the military sector. Similarly, some technical and industrial journals regularly carry material on technological innovations and management practices of the defense sector, in particular those journals which serve the economy as a whole and not single ministries.[13] Finally, it should be noted that some of the standard books on important new technologies are authored by leading specialists of the defense sector. The director of the aviation industry's central technology organisation, the Research Institute of Technology and the Organisation of Production (NIAT), P.N. Belyanin, for example, is responsible for major works on industrial robots and flexible manufacturing systems, the latter

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[8] *Teknika i Nauka*, 1986, No. 4, p. 21; 1984, No. 6, p; 16; 1981, No. 3, p. 25.

[9] For industrial robots, see Yu.G Kozyrev and Ya. A.Shifrin (eds.), *Sovremennye promyshlennye roboty. Katalog*, Moscow, "Mashinostroenie," 1984, pp. 143-4, which makes reference to the products of at least eight defense industry ministries.

[10] See J. Cooper, "Western Technology and the Soviet Defense Industry" in B. Parrott (ed.), *Trade, Technology, and Soviet-American Relations*, Bloomington, Indiana University Press, 1985, p. 188.

[11] For examples see *Tekhnika i Nauka*, 1981, No. 1, p. 25 and Yu.G. Kosyrev and Ya. A. Shifrin, *loc. cit.*

[12] *Nauchno-tekhnicheskaya Informatsiya*, Series 1, 1975, No. 7, p. 24.

[13] For example, *Mekhanizatsya i Avtomatizatsiya Proizvodstva* and *Standarty i Kachestvo*.

including detailed descriptions of installations developed by organisations of the industry.[14]

(III) EXHIBITIONS AND CONFERENCES

The national exhibition centre in Moscow, VDNKh, plays an increasingly important role in promoting new technologies and progressive management practices, not only by presenting exhibitions, but also by making available documentation and organising seminars and conferences. VDNKh regularly features the technology and management experience of leading defense industry enterprises, in particular those known for their civilian activities. Exhibits in recent years have included the Nizhnii-Tagil "Uralvagonzavod," the Ustinov (Izhevsk) "Izhmash" association, and the Vyatsko-Polyany and Kurgan machinebuilding works, all of the Ministry of the Defense Industry.[15] One ministry, for shipbuilding, has its own permanent pavillion. More generally, conferences provide occasions for the participation of representatives of defense industry organisations. Conferences on new production technologies often feature leading specialists of the military sector and sometimes take place at locations where local defense industry enterprises are known to have achieved successes in the technologies concerned. An example is a national conference on robotised production systems which took place at Vladimir in October 1978. Participants included Belyanin and other specialists from NIAT; Vladimir is near Kovrov, where there are two defense industry plants well-known for their achievements in robotics.[16]

(IV) SCIENTIFIC AND TECHNICAL SOCIETIES (NTO)

In principle the system of voluntary Scientific and Technical Societies (NTO) should provide a framework well-suited to facilitating the transfer of technologies from the defense sector to civilian industry. The chairman of the national council of the NTOs, Academician Yu. Ishlinskii, has no doubt wherein lies the strength of these societies: "Above all in the fact that (they) form a special mechanism, distinctive of them alone, linking specialists engaged in the solution of specific problems regardless of where they live and work." [17] With a total national membership of some 12 million scientists, engineers and worker-inventors, the twenty-four branch NTOs have republican, regional and city councils, often chaired by eminent specialists. These branch organisations are supplemented by inter-branch committees, some of which would appear to be well adapted for promoting inter-sectoral transfers, in particular the committees for the automation and mechanisation of production processes, and for problems of quality, reliability and standardisation.[18] The branch NTOs and inter-branch committees organise

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[14] P.N. Belyanin, *Promyshlennye roboty i ikh primenenie*, Moscow, "Mashinostroenie," 2nd edn., 1983; P.N. Belyanin and V.A. Leshchenko (eds.), *Gibkie proizvodstvennye kompleksy*, Moscow, "Mashinostroenie," 1984.

[15] *Mekhanizatsiya i Avtomatizatsiya Proizvodstva*, 1985, No. 1, pp. 37–8; *Sotsialisticheskaya Industriya*, 19 January 1985.

[16] *Stanki i Instrument*, 1979, No. 2, pp. 35–6.

[17] *Tekhnika i Nauka*, 1985, No. 10, p. 2. Ishlinskii is a leading specialist in the field of mechanics who has carried out important research in the field of inertial guidance systems and gyroscopes; it would be surprising if he himself has not participated in military projects.

[18] See *Tekhnika i Nauka*, 1985, No. 12, pp. 1–7.

conferences, publicise technological innovations, and participate in practical research and organisational activity for the development and diffusion of new technologies and managerial practices.

(V) ACADEMY AND HIGHER EDUCATIONAL INSTITUTES

There is no doubt that many institutes of the USSR and republican Academies of Sciences undertake R&D for both military and civilian purposes. During the early 1960's the Academy system reduced its involvement in applied, technical research, but in recent years this policy has been reversed. The creation of a new division for informatics, computing and automation, the reorganisation of the division of mechanics and control systems to strengthen its orientation to the machinebuilding industry, and the election of Yurii Marchuk as President provide evidence of the current determination to harness the Academy's research effort more effectively to the process of industrial modernisation. There is also evidence of the increasing involvement of the Academy in military-related research.[19] Taken together these two trends should facilitate technology transfer between the military and civilian sectors. Standing outside the industrial ministerial system with its notorious departmentalism, academy institutes, together with those of the higher educational system, are in a good position to perform a mediating function, maintaining relations with organisations in both sectors. The Paton electro-welding institute of the Ukrainian Academy, so often cited as an example of good practice, is known to have extensive involvement in the space program and can be assumed to work also on military-related projects. The new technologies it has pioneered in quality metallurgy and welding are now finding increasing application in the civilian economy. In Kiser's words, "Does Boris Medovar of the Paton Institute go blank when he switches his hat from military consultant researcher to civilian researcher?" [20]

Higher educational establishments (VUZy) are similarly well-placed to mediate between the two sectors. It has long been the practice for leading scientists, designers and engineers of the defense industry to undertake teaching at VUZy, and for VUZy to perform contract research for industry, both civilian and military, sometimes on a substantial scale. The active role of educational establishments in the development of significant new technologies is exemplified by the Central Research Institute of Robot Technology and Technical Cybernetics of the Leningrad Polytechnic Institute. This serves as the lead organisation for robotics in the Soviet Union and evidently maintains contact with robot development work undertaken by organisations of civilian and defense industry ministries alike.

(VI) INTER-BRANCH SCIENTIFIC AND TECHNICAL COMPLEXES (MNTK)

Since the 1960's the State Committee for Science and Technology has coordinated inter-branch programs for the development of new

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[19] See John R. Thomas, "Militarization of the Soviet Academy of Sciences," Survey, Vol. 29, No. 1 (124), Spring 1985, pp. 29–58.

[20] John Kiser, presentation at conference on Soviet military expenditures, Harvard University, February 1985. Medovar is a prominent specialist of the Paton Institute.

technologies. Such programs have provided a means of linking organisations of different ministries, including R&D establishments of defense industry ministries engaged in civilian work. These programs have often proved less successful than hoped because of the inadequate powers of their lead organisations, and shortcomings in their planning, financing and incentives. In an attempt to concentrate resources on major, national, new technology programs for the current five-year plan a new organisational form has been introduced, the inter-branch scientific and technical complex (MNTK).

The MNTK includes institutes and enterprises of different ministries under the leadership of a head organisation granted quite extensive powers to coordinate all activity for the development of a specific new technology. Initially sixteen MNTK were established; by the end of 1986 there were at least twenty.[21] Each MNTK is led by a general director who appears to have powers comparable to those enjoyed by general designers in the defense industry; indeed it is possible that the formation of the MNTK has been influenced by defense sector experience. At least four of the MNTK so far established are for technologies until recently developed predominantly by organisations of the nine defense industry ministries, namely "Lazernaya Tekhnologiya" (industrial lasers), "Svetovod" (fibre optics), "Personalnye EVM" (personal computers), and "Rotor" (rotary production lines). In line with the trend discussed above, the lead organisations of the first three are institutes of the Academy of Sciences, and while few details are available it is reasonable to suppose that they embrace organisations of both sectors. The third case, "Rotor," is of particular interest and is discussed more fully below. The new MNTK are experiencing many problems in their early stages, but the general principle of concentrating resources on a few priority programs is probably correct and they could yet demonstrate their viability.

(VII) THE COMMUNIST PARTY AND TERRITORIAL COUNCILS AND PROGRAMS

One of the most interesting and potentially important developments in the management of science and technology in the Soviet Union in recent years has been the strengthening of the territorial dimension, with the consolidation of horizontal, inter-branch connections at the levels of the republic, region and city. The evolving forms of territorial planning and management invite comparison with the regional economic councils (*sovnarkhozy*) of the Khrushchev period. The new attempt to create territorial organs for the promotion of technological innovation dates effectively from the 1970's and efforts have intensified during the last five years, with the Leningrad party organisation setting the pace.

Since about 1977 many republican, regional (*oblast'*), and city party committees have established councils for the promotion of scentific and technical progress. These often work within the broader framework of councils of economic and social development. The councils are often chaired by the local party first, or second,

[21] *Sotsialisticheskaya Industriya*, 20 December 1985; *Kommunist*, 1986, No. 14, p. 26.

secretary, or in some cases by a leading specialist from a local institute or enterprise: the chairman of the Kuibyshev regional council created in 1984 is the well-known aeroengine designer Academician N.D. Kuznetsov.[22] Council members normally include party and trade union officials, leading scientists and engineers, directors of enterprises, and activists of the NTOs, regardless of their branch affiliations. Many councils coordinate the work of commissions and sections concerned with particular technologies; again, these bring together specialists of different ministries. As the example of industrial robots discussed below illustrates, these councils and commissions attached to local party committees provide a framework permitting the cooperation of defense sector and civilian organisations on a territorial basis.

In 1983 the Leningrad regional party committee under its then first secretary L.N. Zaikov began work on the elaboration of a territorial-branch program for the period 1985–90. This program, "Intensification-90," provides for a comprehensive set of measures to raise the technical level of the economy of the Leningrad region, with strong emphasis on industrial automation and the widescale use of the latest technologies.[23] In August 1984 this initiative gained the backing of the Party Central Committee, which issued a resolution calling for its emulation by other party organisations. It is already apparent that the "Intensification-90" program involves the cooperation of defense industry and civilian organisations, some aspects of which are considered below in relation to the development of flexible manufacturing systems.

Following the Leningrad example, other republican, regional and city party committees have led work on the elaboration of similar programs for the intensification of production in the 12th five-year plan. It is worth noting that many of the cases discussed in the Soviet press are for industrial centres where defense industry enterprises are known to be strongly represented. Examples include Gor'kii, Tula, Ul'yanovsk, Novgorod, Kiev, Kovrov, Sverdlovsk, Novosibirsk and Chelyabinsk.[24] Moscow also has a program but of less ambitious scope than that of Leningrad; an interesting feature is the scientific leadership role exercised by P.N. Belyanin, director of the aviation industry's central technology institute.[25]

Organised on a predominantly territorial basis, the Communist Party is the most powerful agency in the Soviet economy able to challenge the all-pervasive branch, ministerial, verticalism characteristic of the system. But it is also the Party's ability to handle the problems of secrecy which must give it a particularly important role as a mediating agency between the military and civilian sectors. Not only the Party Central Committee, but also republican and some regional party committees have special defense industry departments able to liaise with other departments concerned with

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[22] *Tekhnika i Nauka*, 1986, No. 3, p. 4.

[23] *Pravda*, 13 August 1984 (Zaikov). According to the program, Leningrad region and city are to receive 137 flexible manufacturing systems, 89 computer-aided design and production preparation systems, and 1,700 industrial robots, with a sevenfold increase in the size of the computer stock (Izvestiya, 30 April 1985).

[24] *Sotsialisticheskaya Industriya*, 19 November 1986; *Trud*, 24 April 1986; *Sotsialisticheskaya Industriya*, 23 July 1986; *Standarty i Kachestvo*, 1986, No. 9, p. 66; *Pravda Ukrainy*, 18 January 1986; *Izvestiya*, 17 September 1986 and 4 February 1985; *Kommunist*, 1986, No. 8, p. 41.

[25] *Izvestiya*, 4 February 1985.

the economy, and it is reasonable to assume that they are able to ensure that contacts between the two sectors do not infringe national security.

(VIII) THE MILITARY-INDUSTRIAL COMMISSION AND THE BUREAU OF MACHINEBUILDING

For many years the nine defense industry ministries have had a superior coordinating agency in the form of the Military-Industrial Commission of the Presidium of the USSR Council of Ministers. The current chairman of the Commission, Yu.D. Maslyukov, had direct personal experience of civilian activity in the defense sector when he served from 1970 to 1974 as chief engineer of the vast "Izhmash" association of the Ministry of the Defense Industry,[26] This works, the chief designer of which is M.T. Kalashnikov, produces passenger cars, motorcycles, machine tools and other equipment for the civilian economy. With the creation at the end of 1985 of the Bureau of Machinebuilding of the USSR Council of Ministers the eleven civilian engineering ministries now also have an equivalent coordinating agency. The Bureau's chairman, I.S. Silaev, was formerly minister of the aviation industry.[27] Thus the civilian machinebuilding industry has a new leadership with direct experience of the defense sector and a coordinational agency which may well be modeled on the Military-Industrial Commission. Given the policy commitment to making greater use of defense industry experience in the civilian economy, it is likely that the new Bureau has as one of its functions liaison with the Commission to facilitate transfers and cooperation between the two sectors.

Before considering some of the evidence on inter-sectoral technology transfers it is worth noting that Silaev is not the only recent example of a personnel transfer from the defense sector. Two of the eleven civilian engineering branches have ministers with past experience of the defense industry (S.A. Afanas'ev of heavy machinebuilding and V.M. Velichko of power engineering), as has the chairman of the supply organisation, Gossnab (L.A. Voronin). Gosplan has several such transferees, including, first deputy chairman for general affairs A.A. Reut (previously a deputy minister of the radio industry), G.B. Stroganov, deputy chairman with responsibility for the civilian engineering industry (formerly a deputy minister of the aviation industry), and V.V. Simakov, head of the science and technology department (previously head of the scientific and technical administration of the communications equipment ministry).[28] It seems reasonable to conclude that the occupation of key posts in the civilian economy by officials with a defense sector background should facilitate the development of contacts between the two sectors.

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[26] Sotsialisticheskaya Industriya, 3 November 1970; *Izvestiya*, 18 November 1985.

[27] Silaev's first deputy, Yu.V.Konyshev, was previously a deputy minister of the aviation industry and before that director of the Ulan-Ude aviation works, a factory which in addition to building the Mi-8 (Hip) helicopter, manufactures washing machines on a large scale (Sobranie Postanovlenii Pravitel'stva USSR, 1986 (4/27) and 1982 (13/72); *Pravda*, 16 June 1981).

[28] *Pravda*, 5 December 1985; *Sobranie Postanovlenii*, 1984 (26/143); *Radio*, 1984, No. 5, p.2 and *Trud*, 7 December 1986.

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Some Examples of Technology Transfer

(i) industrial robots

From the very beginning of robotics in the Soviet Union organisations of the defense industry have played a prominent role. The first two Soviet industrial robots created in 1971, the "UM-1" and "Universal-50," were products of central technological institutes of defense industry ministries. The "UM-1" was designed by a team led by P.N. Belyanin, director of the aviation industry's institute, NIAT, and was the first robot to enter serial production in the years 1972-74.[29] During the formative period of the Soviet robot industry, up to 1980, the aviation industry was responsible for almost a quarter of all robots built.[30] Belyanin now also occupies the position of deputy chief designer for robots of the State Committee for Science and Technology.[31] Robots manufactured by enterprises of the defense sector are installed at many civilian factories: models in wide use include the "PR-10I" of the aviation industry, the "Universal" and "Tsiklon," apparently of the missile-space industry, the "RF-202" of the radio industry, and the "Brig" of the shipbuilding industry. The latter model is now also being produced by enterprises of at least three civilian machinebuilding ministries.

A distinctive feature of the development of Soviet robotics has been the substantial role played by territorial programs led by local party organisations. The pioneer was the Leningrad regional party committee, which in 1977 created a coordinating council for problems of robot technology. The council includes representatives of leading institutes and enterprises engaged in the development and production of industrial robots, and has a number of sections concerned with particular questions, one of the most important of which is headed by the shipbuilding industry's central technological institute, the scientific-production association "Ritm." Under each section a number of enterprises have been designated "base" organisations, serving as demonstration centres for groupings of local factories.[32] It is clear that a number of these "base" enterprises belong to the defense sector. The activities of the council have included the organisation of robot production on a cooperative basis with the involvement of enterprises of different ministries; an example is a model (the "MP-9") assembled at the "LOMO" association of the Ministry of the Defense Industry, with components supplied by other associations, including "Svetlana" and "Pozitron" of the electronics industry.[33] Since 1977 this initiative has been emulated in other regions and enterprises of the defense sector have often played a leading role. Thus in the Gor'kii region enterprises have been grouped around the strongest lead organisations for the introduction of robots; these include the aviation works, the "Krasnoe Sormovo" factory of the shipbuilding industry,

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[29] P.N.Belyanin, *Promyshlennye roboty i ikh primenenie*, 2nd edn., Moscow, 'Mashinostroenie', 1983, p.10.

[30] *Sotsialisticheskaya Industriya*, 20 August 1980 and *Narodnoe khozyaistvo SSSR v 1922-1982gg.*, Moscow, 1982, p.191.

[31] *Ekonomika i Organizatsiya Promyshlennogo Proizvodstva*, 1982, No.2, p.39.

[32] E.I. Yurevich, *Promyshlennaya robototekhnika i gibkie avtomatizirovannye proizvodstva*. Leningrad, Lenizdat, 1984, pp. 5 and 21-5.

[33] *Leningradskaya Pravda*, 1 July 1980 and 4 January 1981.

and the local television factory of the radio industry.[34] In general, it appears that the robotics program has helped to stimulate new forms of cooperation on a territorial basis with the active participation of organisations and personnel of the defense sector.

Before leaving robotics it is interesting to note that some of the prominent research specialists in the field have had association with the space program, including the founding "father" of Soviet robotics, the late Academician I.I. Artobolevskii, E.P. Popov, who leads the robotics research program of the higher educational sector, and D.E. Okhotsimskii, a leading expert in the theory of "intelligent" robots. Recently a spin off from the space program has taken a more direct form: the Moscow "Krasnyi Proletarii" works has introduced a new automatic system for testing robots developed jointly with specialists of the Institute of Space Research of the USSR Academy of Sciences. It is based on systems used to test apparatus sent up in satellites.[35]

(II) FLEXIBLE MANUFACTURING SYSTEMS

In the Soviet Union the 1980's have seen a rapid growth of interest in the creation of flexible manufacturing systems (FMS). In the development of this important new technology organisations of the defense sector have played an active role and some of the most advanced applications to date have been located at enterprises of defense industry ministries. As with industrial robots, the aviation industry's NIAT, under Belyanin, has been at the forefront in the creation of FMS, being responsible for some of the most elaborate systems.[36] A number of enterprises of the defense sector are building machining centres and modules for incorporation in FMS and in some cases this clearly involves cooperation with organisations of the Ministry of the Machine Tool Industry. Thus the Vladimir "Tekhnika" association of the aviation industry, well-known for its production of advanced machine tools and robots, regularly exchanges information with the specialised industry's leading association in Ivanovo.[37]

Within the framework of the "Intensification-90" program Leningrad industry is accumulating experience in the creation of FMS with the pace being set by organisations of the defense industry. Associations with FMS include "LOMO" and "Kirovskii Zavod" of the Ministry of the Defense Industry, "Krasnyi Oktyabr" of the aviation industry, "Proletarksii Zavod" and "Ritm" of the shipbuilding industry, and "Zavod im.Kalinina" of the Ministry of Machinebuilding. These works are serving as demonstration centres for the new technology; the system at "Zavod im.Kalinina," for example, is reported as having been inspected by a large number of visitors.[38] The problems of the creation and operation of some of these FMS are being publicised quite extensively, in particular by the local daily, *Leningradskaya Pravda*, in what appears to be a deliberate effort to diffuse the experience of the defense sector within

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[34] *Sotsialisticheskaya Industriya*, 2 October 1982.
[35] BBC, SWB, SU/W1420/A/10, 12 December 1986.
[36] Described in detail in P.N. Belyanin and V.A. Leshchenko (eds), *op.cit.*, pp. 166–200.
[37] *Ekonomicheskaya Gazeta*, 1983, No. 43, p. 8.
[38] *Leningradskaya Pravda*, 11 October 1985.

the framework of "Intensification-90." There are signs that this Leningrad program is being replicated in other regions: in Novgorod, for example, there is now a program for the development of FMS involving the cooperation of specialists of local associations and enterprises, including "Volna," "Planeta" and "Start" of the electronics and radio industries.[39]

(III) ROTARY PRODUCTION LINES

In September 1984 the Politburo called for the development and wide diffusion of rotary production lines. After many years of struggle to gain recognition of this technology, this was a triumph for its inventor L.N. Koshkin, who later in the same year gained election to the USSR Academy of Sciences. As noted above, one of the first inter-branch scientific and technical complexes was "Rotor," formed for the creation and introduction into the economy of rotary lines, with Koshkin's own design bureau as its lead organisation. The ministerial affiliation of this design organisation has not been revealed, but there seems little doubt that it is under the Ministry of Machinebuilding.[40] This is a technology of the defense sector and as such provides an interesting case study, not the least because Koshkin has tried once before to secure its wide adoption in the civilian economy.

The novelty of the rotary production line lies in the combination of machining and transport functions giving very high rates of productivity. The lines can be used for processing many types of materials and in principle they are applicable in a diverse range of industries. Between 1959 and 1964, at a time when industry was organised on a territorial basis, Koshkin and his supporters conducted a vigorous campaign to obtain the development of rotary lines by institutes and enterprises under the regional economic councils. In the face of strong opposition from the traditional machine tool industry, some limited success was achieved, but this stage of development appears to have ended abruptly with the restoration of the branch ministries in 1965.[41]

Within the framework of the MNTK "Rotor," Koshkin's design bureau will lead work for the development and production of rotary lines in a number of civilian machinebuilding ministries.[42] It is planned to have some 4,000 lines in use by 1990, although Koshkin himself has argued for a more ambitious target; he has claimed that widescale adoption of rotary lines could free 10-12 million people from their present jobs within five years![43] However, it is clear that there is only limited activity at present and the only enterprise identified by the author as having design and production capacity for rotary lines is Koshkin's old defense industry

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[39] *Sotsialisticheskaya Industriya*, 24 November 1985.

[40] The location of the design bureau also has not been revealed, but it may be significant that Koshkin and some of his leading associates (e.g. I.A. Klusov and V.V. Preis) have connections with the Tula Mechanical Institute. Koshkin's invention dates from the time of the war, when he worked at the Ul'yanovsk im. Volodarskogo munitions plant. He created his design bureau with the backing of the then Commissar for Armaments, D.F. Ustinov (see *Sovetskaya Rossiya*, 1 March 1985).

[41] See *Izvestiya*, 11 March 1960 (Koshkin); 14 September 1960 (V.Dikushin et al.); 1 February 1961 (Preis); 7 June 1964 (Morkovin and Alekseev).

[42] *Pravda*, 14 October 1986.

[43] BBC, SWB, SU/W1413/A/12, 24 October 1986.

plant at Ul'yanovsk.[44] Koshkin is a controversial figure. He has antagonised many specialists by his forthright attacks on conventional forms of automation, and rotary lines are not without their critics.[45] But the case of rotary lines nevertheless provides an interesting example of an attempt to transfer a technology developed within the defense sector to the civilian economy.

(IV) METALLURGICAL TECHNOLOGIES

Some branches of the defense industry have quite substantial capacities for the production of ferrous and non-ferrous metals and associated metallurgical research establishments. In particular, this applies to the aviation industry, which has two well-known materials research institutes, the All-Union Institute of Aviation Materials (VIAM) and the All-Union Institute of Light Alloys (VILS) and a number of large metallurgical works which regularly cooperate with civilian organisations in the development of new technologies. Recent examples include joint work with the power engineering industry to create components for gas pipeline compressor units, and with the electrical engineering industry for the development and production of cooling systems for high-powered semi-conductor devices.[46] One of the leading aviation industry metallurgical works, the Kuibyshev Lenin factory, has developed new technologies for processing aluminum and its alloys, including electromagnetic casting, and also supplies high-quality materials to civilian customers, including the Tol'iatti "VAZ" auto plant.[47] The Ministry of the Defense Industry has its own steel making capacity and a Central Research Institute of Metals in Leningrad, but it has not proved possible to identify transfer from the latter to the civilian economy.

(V) TECHNOLOGY FOR AGRICULTURE, CONSUMER INDUSTRIES, AND THE HEALTH SERVICE

During the last twenty years there have been a number of high-level appeals for the defense industry to contribute to the development and production of equipment for agriculture, the consumer industries and the health service, the most recent being Zaikov's above-cited speech in the summer of 1986. There is evidence that this pressure has produced results. All the ministries of the defense sector are involved in some way in supplying equipment for the agro-industrial complex as it has become known in the Soviet Union. Thus organisations of the Ministry of the Defense Industry manufacture heavy-duty tractors, irrigators and mineral fertiliser spreaders; the Ministry of Shipbuilding supplies irrigators and tractor trailers; the missile-space industry under the Ministry of General Machinebuilding makes tractors; products of the Ministry of Machinebuilding include anti-hail rocket installations and seed drills; the Ministry of Medium Machinebuilding supplies equipment for making dried milk; and the aviation industry supplies tractor en-

[44] *Kommunist*, 1985, No.9, pp,61-2.
[45] See *Sovetskaya Rossiya*, 29 May 1986 (Koshkin).
[46] *Sotsialisticheskaya Industriya*, 4 May 1984 and 18 April 1986.
[47] *Pravda*, 1 April 1984. Sheet aluminum produced by this factory was also used in building the 'Salyut' space stations.

gines, mini-tractors and cultivators, hen batteries, and milk separators.[48] In some cases leading enterprises of defense industry ministries are involved in cooperative production schemes with neighboring enterprises of other ministries: examples include the production of forage harvesters (Voronezh and Sverdlovsk), hay tedders (Novgorod), irrigators (Volgograd and Ul'yanovsk), and, a recent development, rotary lines for making ice cream, centred on the "Izhmash" association at Ustinov (Izhevsk).[49] Some enteprises also manufacture equipment for light industry, including textile machinery built by the Ministry of Machinebuilding.

One field characterised by a quite high level of military-space and civilian sector cooperation is the development and production of medical equipment. A 1967 Council of Ministers decree on the medical industry made reference to the involvement of all the defense industry ministries, including the nuclear weapons branch which was to supply X-ray equipment.[50] Since then there have been many specific examples and several State Prizes have been awarded for successful cross-sectoral cooperation. In some cases the development work involved eminent specialists: the rocket control expert, the late Academician N.A. Pilyugin, for example, led work in the Ministry of General Machinebuilding for the creation of monitoring equipment for cardio-vascular operations.[51] Other examples include the creation of infra-red scanners by organisations of the Ministry of the Defense Industry, the involvement of the electronics industry in the development of laser surgical instruments, and of the radio industry in the creation of micro-processor based equipment for cardio-vascular research.[52]

Spinoffs From the Space Program

In recent years there has been evidence of a mounting concern that technological innovations associated with the space program should find wider application in the economy. Much of the equipment for the program is supplied by the Ministry of General Machinebuilding, which also produces strategic missiles, and for this reason problems of secrecy are likely to be especially acute. In October 1985 the creation of a new organisation, Glavkosmos, was announced. Under the leadership of A.I. Dunaev, previously a deputy minister of the general machinebuilding ministry, this Main Administration for the Creation and Use of Space Technology in the National Economy and Space Research appears to represent a deliberate attempt to "civilianise" at least part of the space program in order to reap greater economic benefit.[53] A prominent advocate of the need for more transfers from the space program is Academician V.P.Mishin, formerly a close associate of Korolev, and more recently known as a leading specialist in the field of computer-

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[48] See R. Amann and J. Cooper (eds.), *op. cit.*, p. 35, and *Sovetskaya Rossiya*, 20 July 1986 (anti-hail rockets).

[49] *Trud*, 16 September 1986; *Pravda*, 3 June 1986; BBC SWB SU/W1289/A/8, 25 May 1984; *Sotsialisticheskaya Industriya*, 6 May 1985; *Sovetskaya Rossiya*, 17 January 1985; *Izvestiya*, 23 November 1986.

[50] *Resheniya partii i pravitel'stva po khozyaistvennym voprosam*, Vol. 6, Moscow, 1968, pp. 563-6.

[51] *Sotsialisticheskaya Industriya*, 19 April 1983 and *Pravda*, 3 March 1985.

[52] *Izvestiya*, 14 July 1984; *Pravda*, 9 April 1984; *Meditsinskaya Gazeta*, 15 May 1985.

[53] See *Izvestiya*, 13 October 1985.

aided design. Writing in 1983, Mishin acknowledged that, as a rule, the many inventions associated with the development of new space vehicles "for many reasons" did not find wide application in the economy. "The achievements of the space industry," he concluded, "must become the property of industry as a whole." [54] However, Mishin also provided some examples of successful transfers in the fields of cryogenics, storage systems for gases and liquids, composite materials, and new production technologies such as plasma deposition and novel types of welding. Interestingly, these are fields in which R&D for the space program has been undertaken outside the defense sector, narrowly defined, by organisations serving both civilian and military-space purposes. The Paton Institute of the Ukrainian Academy has been responsible for new welding and plasma technologies, while the leading industrial cryogenics organisation is the scientific-production association "Kriogenmash" of the Ministry of Chemical and Oil Machinebuilding.[55] These examples suggest that spinoffs from the space program are a reality, but that they are more easily realised if the technologies concerned are developed by organisations outside the specialised defense industry.

Conclusion

In this chapter we have considered a number of agencies and mechanisms for the transfer of technology from the defense sector to the civilian economy in the Soviet Union and provided some evidence that such transfers are taking place, and that there is now a definite policy commitment to the expansion of such cross-sectoral cooperation to the general benefit of Soviet economic performance. It is difficult to gauge the scale of transfer activity. Considerations of secrecy not only complicate the transfer process, but also inhibit the publication of information about relations between the military and civilian sectors. The available evidence suggests that cooperation and transfers are most extensively developed in relation to production technology and materials, together with certain specific fields such as medical technology. It is not claimed here that technology transfers from the defense sector are taking place on a very large scale, or that they are likely to have any dramatic impact on the performance of the economy. However, the available evidence does indicate that there may be limited, but worthwhile, benefits from the pursuit of a more energetic transfer policy, and also more general advantage from the development of closer relations between defense sector and civilian organisations and personnel, especially at the local, territorial level.

It is sometimes argued that transfers from the defense sector can have only limited impact on the civilian economy in so far as the priority enjoyed by the former cannot be widely diffused in the latter. But this argument is open to question. Firstly, the civilian economy has its own priority ranking and differentiation in terms

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[54] V.Mishin, "Zemnye programmy kosmonavtiki", *Kommunist*, 1983, No. 6, p. 88.

[55] From 1972 to 1986 "Kriogenmash" was headed by the late V.P. Belyakov. Significantly, signatories of his obituary included O.D. Baklanov, Minister of General Machinebuilding, and leading figures of the space program, including V.P. Glushko, V.S. Avduevskii and V.P. Barmin (*Pravda*, 29 August 1986).

of the quality of resources available to particular sectors.[56] It is a mistake to think in terms of the civilian economy in general; transfers are most likely to be directed towards the highest priority civilian activities, in particular the major civilian engineering industries, and to the extent that they are, any loss of effectiveness will be minimised. Secondly, the problem of priority may apply more to the transfer of managerial practices than to the production processes and hardware discussed here, although, again, the first point still applies, so that even managerial experience may be transferable with positive results.

Looking to the future, some factors can be identified favourable to an expansion of transfer activity. It has been argued that during the period of the current five-year plan the defense sector's own investment needs are less intense because of the high volume of investment in the preceeding years.[57] To the extent that this is true there should be more scope for transfers and cooperation in the field of production technology. Secondly, the trends of development of technology itself put increasing emphasis on technologies for which hitherto the defense sector has had major responsibility, but which are now crucial to the civilian economy. Examples include the whole field of information technology, lasers, quality metals and composites, and some types of advanced manufacturing technology. If the modernisation of the civilian economy is to be successfully undertaken there will have to be more cross-sectoral cooperation. Thirdly, there is increasing evidence that this situation is appreciated by the country's top leadership, and there are personnel in place in key positions who are well-qualified to secure the transfers and cooperation required. In the practical realisation of the policy central figures must include Zaikov, Maslyukov and Silaev; all three have direct, personal experience of the civilian involvement of the defense sector. The impact of one further factor is less certain: the state of East-West relations. On the one hand, a more relaxed international climate should, in principle, facilitate the use of defense industry experience in the civilian economy, but on the other, it could reduce the intensity of the pressure to do so. In the period ahead the degree of success achieved in harnessing the defense sector to the task of revitalising the economy could well provide a good measure of the general achievement in realising the new economic policy now being pursued under Gorbachev.

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[56] This point is developed in the author's article, "Technology in the Soviet Union", *Current History*, Vol. 85, No. 513, October 1986, pp. 317-20 and 340-2.

[57] U.S. Congress, Joint Economic Committee, *Allocation of Resources in the Soviet Union and China—1985*, Washington, USGPO, 1986, pp. 51-2.

THE SOVIET WEAPONS INDUSTRY: AN OVERVIEW

By Shelley Deutch*

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I. Summary

The Soviets have traditionally run their weapons industry in a way that exploits the priority given to defense and the advantages of a command economy, and minimizes the impact of their technical weaknesses. Soviet weapons acquisition has been characterized by centralized management by party and government organizations; leadership authorization of weapon programs and their funding early in the acquisition process; relatively simple, low-risk weapon designs, emphasizing standard components and existing technologies; easily manufactured systems, which can be fabricated by a technologically unsophisticated industrial base with semiskilled or unskilled labor operating general purpose conventional machine tools and equipment; long production runs yielding large numbers of weapons; and weapon advances that emphasize incremental upgrades instead of the development of completely new systems or subsystems. Developments in the economy, technological change, and evolving perceptions of the foreign threat, however, are inducing the Soviets to modify these strategies.

II. Scope and Achievements

The Soviets have consistently accorded high priority to national defense. This commitment—which has not varied substantially with the international climate—led them by the early 1970's to devote greater resources to armaments production than any other country. Nine defense industrial ministries currently oversee thousands of weapon and weapon component plants and at least 450 military R&D organizations. Roughly 50 major design bureaus oversee the development of 150 to 200 major weapon systems, a level of effort sustained for at least the past three decades. About 150 major plants assemble these weapons, and the plants have steadily expanded throughout the postwar era. As with most Soviet

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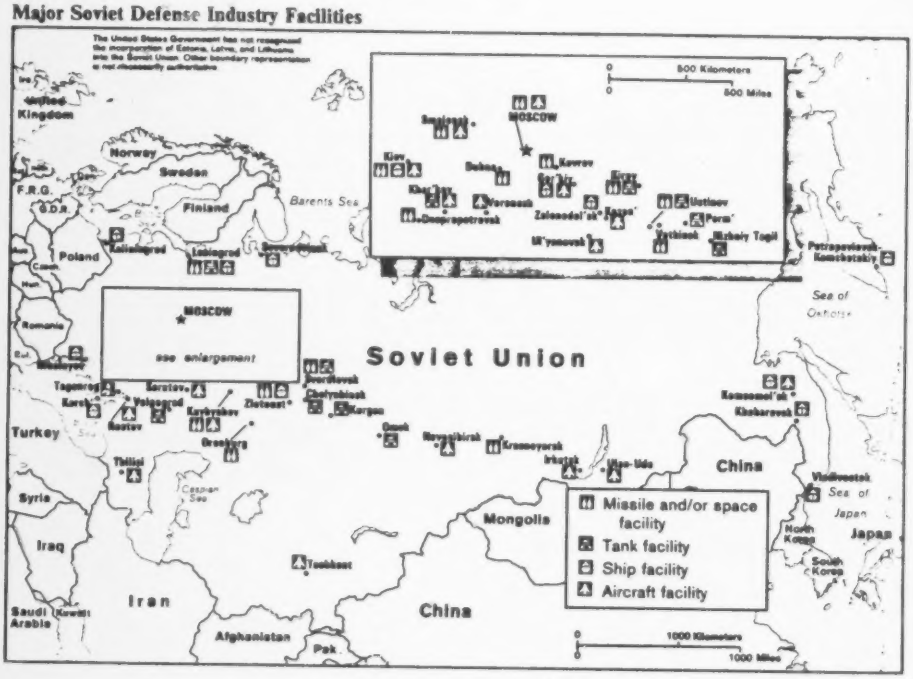
industry, defense industrial production is largely concentrated in the more populated and developed areas of the Western USSR. Designers and producers are supported by a network of facilities that extends throughout Soviet industry and academia. Management of the defense industries—including the nine ministries and the relevant party and government organizations—is based in Moscow.

FIGURE 1

Major Soviet Defense Industry Facilities



ALLOCATION OF ENORMOUS RESOURCES

The Soviets began building up their weapons industry during the 1920s, with goals for developing the military driving investment priorities for the First Five-Year Plan (1928–32). This emphasis on defense continues to this day, with the USSR in the awkward position of having achieved superpower status and yet having per capita consumption statistics equivalent to those of a less developed country.

When Brezhnev came to power in 1964, he initiated an across-the-board modernization and buildup of both strategic and conventional forces. The CIA estimates that Soviet defense expenditures over the next decade—and the subset of those expenditures devoted to procurement—grew at a real average annual rate of about 5 percent.[1] This growth reflected increasing resource commitments to all of the military services and missions.

[1] Procurement includes weapons and equipment produced for the Soviet armed forces but not those produced as prototypes or for export. The term "production" is used to refer to all of the military output of the defense industries.

In the mid-1970's there was a change in the rate of growth of Soviet defense spending as estimated by the CIA.[2] Total defense spending—which includes expenditures for research and development, procurement of weapons and combat equipment, manpower, construction, and operations and maintenance—increased by an average of about 2 percent annually over the next decade. This slowdown in growth was primarily the result of a leveling off—at a high level—in estimated procurement spending. However, it should be kept in mind that Soviet leaders may have had a different perception. Western estimates of real growth are based on Western economic concepts of constant prices. The Soviets do not use these concepts in their published economic data. Instead they use a concept that they call comparable prices, which reflects considerable concealed inflation. If they believe that real growth of defense is best measured by comparable prices, they may perceive more rapid growth in procurement expenditures than shown by Western analysis. They would perceive even more rapid growth if they evaluated defense spending in current prices.

In any case, the share of Soviet resources committed to such procurement is extremely high by international standards. The USSR devotes appreciably higher shares of the output of almost every industry to military procurement than does the United States. Soviet weapons procurement absorbs about 7 to 8 percent of the Soviet gross national product and over a third of the output of the important machine-building sector. The defense industries receive priority access to raw materials and are given preferential access to the transportation and distribution networks for delivering materials. They also have access to the highest quality machinery and labor.[3]

The doubling of defense production capacity since 1965 is another indicator of the priority accorded the weapons industry. Industries producing missiles and aircraft expanded most rapidly. Facilities devoted to R&D for subsystems and components (such as radars, communications systems, and computers) expanded more rapidly than those used for final weapons development, reflecting the increasing complexity of Soviet military equipment. Much of the growth at defense industry facilities is due to the traditional Soviet practice of building new facilities alongside older facilities, which continue producing and maintaining older systems and furnishing spare parts. This practice is partially the result of ineffective incentives to economize on construction, but it has often been necessary because of the unsuitability of older facilities for housing modern production-line tooling. Buildings constructed since the early 1970's, however, are being designed as large, open-spaced structures of modular components. Their added structural strength and flexibility will provide the more vibration-free environment required for a greater variety of precision equipment, and they should allow production lines to be rearranged, upgraded, or replaced periodically as requirements change, thus lessening future requirements for new construction.

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[2] See DIA-CIA report DDB-1900-122-86, *The Soviet Economy Under a New Leader*, July 1986.
[3] For an alternative view of labor in the defense industries, see Mikhail Agursky, *The Soviet Military-Industrial Complex*, Jerusalem: The Hebrew University, 1980.

Although the leadership has given the defense industries priority with respect to resources and personnel, it has endeavored to ensure that there are civilian spinoffs in return.[4] At the 24th CPSU Congress in 1971, Brezhnev stressed that the defense industries were working for the economy as a whole. He noted that 42 percent of the output of the defense industries was devoted to civilian goods (some Western analysts maintain he was referring to just one ministry, the Ministry of the Defense Industry). More recently, General Secretary Gorbachev called upon the defense industries to share some of their management expertise with the rest of the economy, and in the past year several defense industrial ministries have been warned of the need to improve the quality and timeliness of their consumer goods production. In any case, the industry's support to the Soviet economy is extensive—defense industry enterprises produce many civilian products, ranging from refrigerators and baby carriages to electronics, tractors, and railroad cars.

HIGH LEVEL OF PRODUCTION

The impressive size of the Soviet weapons industry is primarily due to the large force requirements of the Soviet military. Only the People's Republic of China has more men under arms, and in number of weapons systems, the United States leads the Soviet Union in only a few types of military equipment, such as aircraft carriers. Maintaining the combat effectiveness of the Soviet forces demands massive buys of regularly upgraded and improved weapon systems. Despite the slowdown of growth in military procurement, the Soviet weapons industry is producing enough equipment to modernize Soviet forces and at the same time reap substantial benefits—both financial and political—from the export of Soviet weapons.

[4] See the article by Julian Cooper, also in this volume.

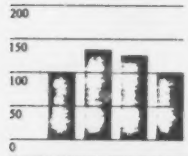
FIGURE 2

Estimated Production of Selected Soviet Weapons, 1966–85[a]

Index: 1966–70=100

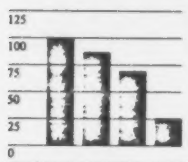
Note scale changes

Aircraft



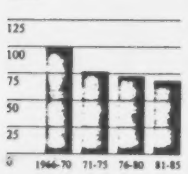
Soviet aviation plants currently produce 10 fighter aircraft models, including the MIG-31 Foxhound, SU-27 Flanker, MIG-29 Fulcrum, and SU-25 Frogfoot. One intermediate-range and two strategic bombers, seven models of transport aircraft, and five helicopter models are also being produced. Several aircraft models are produced for export as well.

ICBMs and SLBMs



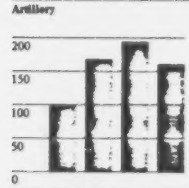
Strategic missile production has been limited in the 1980s as the Soviet defense industries prepare to produce new models to modernize the force. The Soviets are developing a liquid-propellant ICBM to replace their SS-18; a solid-propellant ICBM (SS-25) is now in series production, and a second type (SS-X-24) is in prototype production. Two SLBMs, the SS-N-20 for the Typhoon nuclear-powered submarine and the SS-N-23 for the Delta IV nuclear-powered submarine, are currently in series production, and other SLBMs are in development.

Tanks



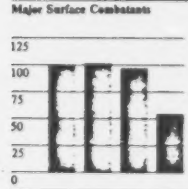
Tanks are the principal offensive component of the Ground Forces. Tank costs increased primarily because of the production of large numbers of T-64s, T-72s, and T-80s in basic, improved, and export versions and the growing cost of their increasingly advanced subsystems and components.

Artillery



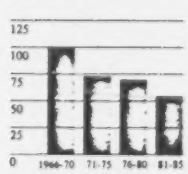
The Soviets have traditionally manufactured large numbers of artillery systems. Recently, increasing numbers of self-propelled systems have been introduced to increase the mobility and firepower of artillery units. Their gun calibers include 122 millimeters (mm), 152 mm (two weapons), 203 mm, and 240 mm (a mortar). Other towed and self-propelled systems are being developed and tested.

Major Surface Combatants



Although the number of major surface combatants produced is declining, the trend toward larger ships with increased endurance, greater weapon loads, and more sophisticated weapons and equipment continues. The Soviets are modernizing their surface fleet through the construction of several classes of large cruisers and destroyers with improved warfighting capabilities. They have also begun outfitting the first unit of a new class of carrier, probably nuclear powered, for conventional takeoff and landing aircraft.

Submarines

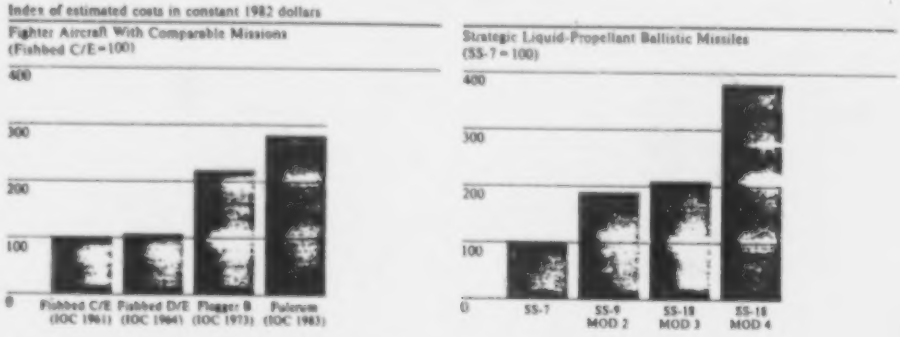


Over the last few years the types of submarines produced have increased at an unprecedented rate. Although production has declined, there has been rapid growth in the diversity of nuclear-powered general purpose units, such as the Akula and Sierra classes.

[a] For each weapon category, the graph shows our estimates, in index form, of the changes in the quantities of new units produced in each five-year period. The figures do not include conversions or refitted and modified older systems. The figures cover all weapons in the selected categories produced by the Soviet defense industries, not just those procured by the Soviet military.

FIGURE 3

Estimated Production Costs of Selected Soviet Weapons*



* The indexes displayed above reflect 1982 dollars, not actual Soviet expenditures. They are based on estimates of what it would cost to produce these Soviet systems in a US factory using US wage rates, material costs, and equipment operating factors.

At the same time, one of the most striking trends in Soviet weaponry is the escalating cost of new systems. Incorporation of more advanced technologies and modernization of the manufacturing base have combined to make new systems far more expensive than their predecessors. As a result, although total numbers produced in many categories of weapon systems have declined, total estimated spending on defense procurement has not.

III. PLANNING AND MANAGEMENT

The Soviets' success in equipping their forces lies in their ability to make long-range, coherent plans; to command and focus resources on the most important programs; and to ensure continued commitment to programs under way. The Soviets have developed a system of planning and management designed to enhance the performance of their planned economy in satisfying the military's requirements for weapons and equipment. However, Soviet military-industrial managers operate in the same central-planning environment as their civilian counterparts and are thus subject to many of the same problems.

STRONG CENTRALIZED MANAGEMENT

Planning for and management of the Soviet weapons industry is the shared responsibility of the party and the government:

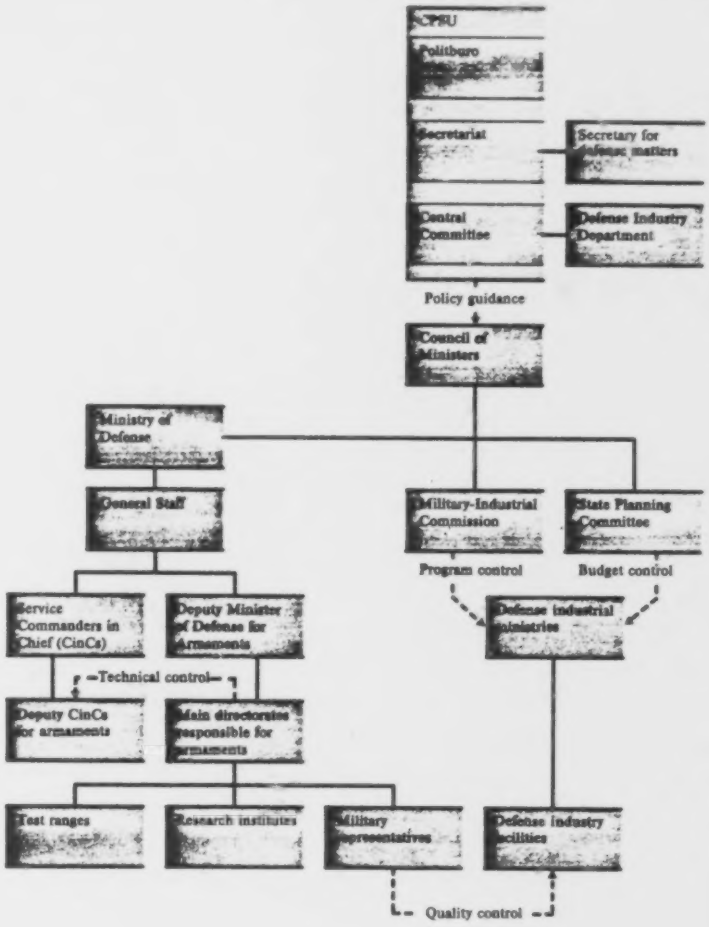
- —The party draws up basic policy guidelines for resource allocation and monitors their fulfillment.
- —The government, through its various ministries, bureaus, state committees, and commissions, runs the economy and its defense-related industrial activities.
- —The Soviet Ministry of Defense (MOD), as part of the government, generates requirements for the defense industries and is the consumer of their products.

High-level representatives of the party and government, including the military, serve on the Defense Council—usually presided over by the CPSU General Secretary—and advise the Politburo on major defense policy issues.

A party secretary with responsibility for defense matters spearheads the party's formulation of defense economic policy. The Central Committee's Defense Industries Department and its counterparts at the local level monitor defense industrial performance.

FIGURE 4

Soviet Bureaucracy for Weapons Acquisition



Government management of the defense industries is centralized in the USSR Council of Ministers. Most of this management is performed by the Council's Military Industrial Commission (VPK), which coordinates and controls military-related research, design, development, testing, and production activities, and serves as a primary orchestrator for defense industrial acquisition and assimilation of foreign technologies. The State Planning Committee (Gosplan) assigns production targets and allocates resources to the defense industries. Other key state committees are:

—The State Committee for Science and Technology (GKNT), which plans and implements scientific-technical policy for the entire Soviet economy. It determines the basic directions for the development of science and technology and works with the VPK to oversee foreign technology acquisition.

—The State Committee for Material-Technical Supply, which distributes supplies to Soviet industrial plants. It implements Soviet defense priorities by rationing goods in short supply to competing users.

—The State Committee for Standards, which sets technical specifications and quality standards for goods produced by Soviet industry.

Each of the nine defense industrial ministries oversees the work of design bureaus, R&D facilities, and production enterprises. Enterprises are frequently combined into production associations, which may also include experimental facilities and R&D units. In many cases an intermediate layer of management—a main directorate or all-union industrial association—has direct responsibility for specific functional areas within the ministries, although the leadership has recently called for these to be abolished in an effort to trim the bureaucracy.

The Ministry of Defense exerts considerable influence on the planning and management of the defense industries. As the primary customer, the MOD is involved in all stages of the arms acquisition process, from generating requirements to overseeing the manufacture and acceptance of new weapons.[5] Through the General Staff and the deputy minister of defense for armaments—whose main armaments directorates provide tens of thousands of on-site military representatives at weapons-related facilities—the MOD wields a vigorous monitoring apparatus. This direct association of consumer with industry provides the quality control and feedback traditionally lacking in the civilian economy and has been a principal reason for the better performance of Soviet defense industries. Evidence of the effectiveness of this system can be found in the July 1986 leadership decision to create a network of inspectors subordinate to the USSR State Committee for Standards to perform a similar quality control function in civilian industries.

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[5] For a detailed look of the Soviet weapons acquisition process, see Michael Checinski, *A Comparison of the Polish and Soviet Armaments Decisionmaking Systems*, Santa Monica, California: RAND Corporation, Report R-2662-AF, January 1981. See also Jerry F. Hough, "The Historical Legacy in Soviet Weapons Development" and Ellen Jones, "Defense R&D Policymaking in the USSR," both in Jiri Valenta and William Potter, *Soviet Decisionmaking for National Security*, London: George Allen and Unwin, 1984.

CONTINUITY AND STABILITY

The long tenure of managers in the Soviet defense industries has lent stability to the administrative apparatus, provided a continuity of approach, and helped to ensure that lessons learned from past experience are passed along. Although age is taking its toll among long-term defense-industrial chieftains, continuity has been maintained by replacing them with their deputies of many years.

One result of this practice has been the development of a network of experienced senior planners and managers who have all worked with one another and who know each other's patterns of operation. The late Minister of Defense Ustinov appears to have been the center of this network. Men whose careers were associated with his today occupy leading positions throughout the Soviet defense industrial management hierarchy. In recent years this network has been spreading throughout the civilian sector as well. Apparently in an effort to share the experience and managerial talent of defense industry administrators, the Soviet leadership has transferred many of them to positions of responsibility throughout the government and party.

PRIORITY CLAIMS ON RESOURCES

The military's requirements for weapons production are detailed in a five-year defense plan, a subset of the five-year plan for the economy as a whole. This military plan covers such activities as training, logistics, and military assistance and spells out the need for new weaponry and research. Long-term forecasts are incorporated into perspective plans for 15 years or longer.

Resources devoted to the military have traditionally been shielded from diversion to other claimants by the mechanics of the planning system. The sheer magnitude of economic and technical data tends to prevent Gosplan from conducting "zero-based" reevaluations of programs and activities. Gross target figures probably are not the product of detailed calculations of defense and civilian needs, but percentage adjustments to prior-year aggregate figures. Moveover, Gosplan tries to minimize changes in the assignments of existing resources to maintain predictability in planning key military and civilian projects. Participation in the planning process by the VPK—which is staffed primarily with defense industry and military officials—further protects military industrial interests.

In addition, the extreme secrecy accorded national security planning has helped prevent other sectors from laying claim to defense production resources. This secrecy allows defense industry managers to make claims on resources without having to justify their requests openly. On the negative side, however, the secrecy inhibits the free flow of ideas between the defense and civilian sectors of the Soviet economy. Publication of scholarly work is difficult, discouraging many talented scientists and engineers from working in the defense sector.

The same mechanisms that protect military interests probably—in the short run—also make it difficult to change the level of military output, at least in peacetime. Dramatic changes in output require corresponding changes in capital investment, materials allocation, and labor assignments. Furthermore, because defense pro-

duction is so closely tied to the rest of industry, major changes are not possible without greatly disrupting patterns in the rest of the economy. Thus, while the system's momentum facilitates smooth programs, it also makes it more difficult to terminate or redirect a program in response to changing threats or technology.

The momentum engendered by the planning system has sometimes made it necessary for top leaders to intervene when entirely new programs or directions are sought. This occurred frequently under Stalin, who, for example, singlehandedly decreed the need for a Soviet blue-water navy and forced through a crash shipbuilding program on the eve of World War II. Such leadership pushes have been effective in engineering wholesale changes in resource allocations to new projects. The momentum of the planning system is such that the required resources often do not flow rationally, however, but rather appear in a "spasm" in which more resources are allocated at one time than can be fruitfully absorbed.

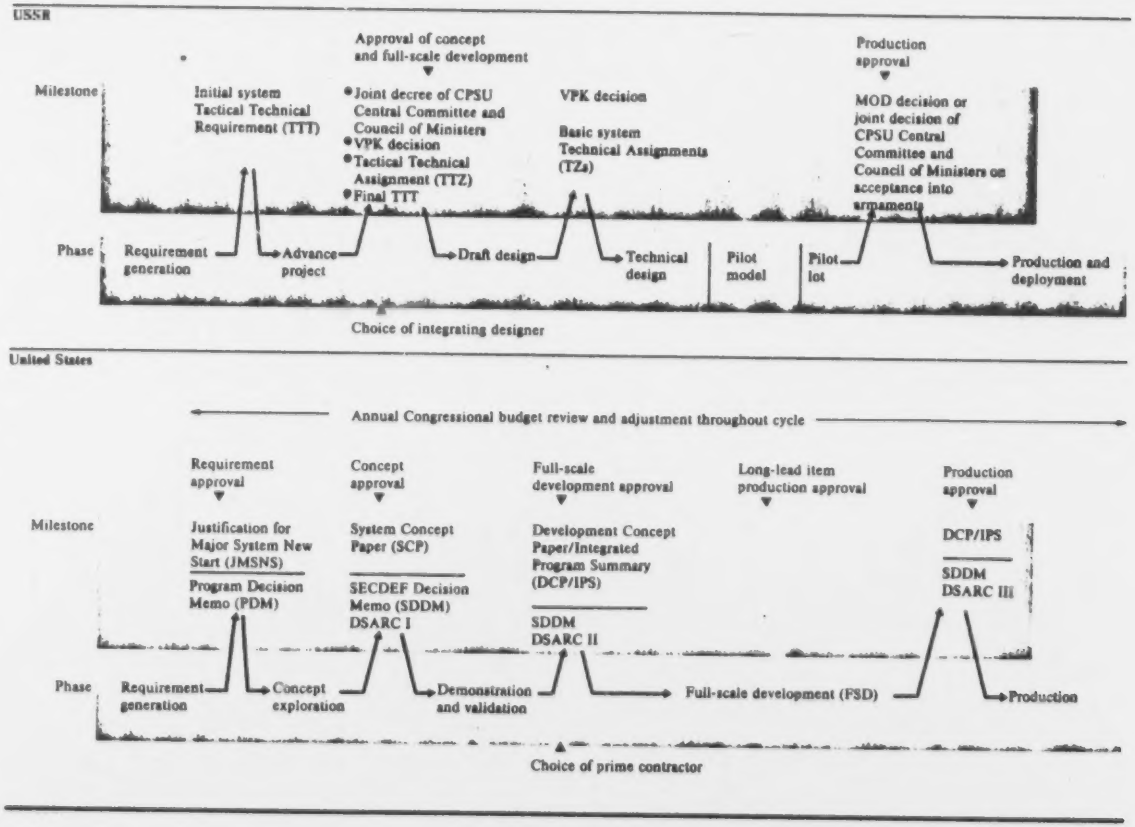
EARLY, ONE-TIME AUTHORIZATION OF PROGRAMS

The Soviet weapon development process proceeds in an orderly progression from requirements formulation up to serial production. The entire procurement planning process is supervised and coordinated by a deputy minister of defense for armaments, currently Army General Vitaliy Shabanov. Because of the centralized nature of this system, Soviet defense-industrial managers are assigned military requirements relatively unbuffeted by interservice rivalry.

Weapon programs are authorized by a joint decree of the Central Committee and Council of Ministers. Formal approval may be a function of the Politburo. The decree—signed by both the CPSU General Secretary and the Chairman of the Council of Ministers—allows Soviet leaders to select weapon systems they want to develop and quickly commit resources to them. It has no direct counterpart in terms of authority in the United States, but it has the effect of combining in one decision the Department of Defense approval of a program, a presidential decision authorizing top priority, and multiyear funding of the program by Congress. This one-time authorization contrasts dramatically with the U.S. practice of reviewing major weapon programs each year and adjusting their funding throughout the R&D and deployment cycles.

FIGURE 5

A Comparison of US and Soviet Weapon Procurement Cycles



Coordinated operational and technical requirements are levied on the appropriate Soviet defense industrial ministry. Within that ministry, a design bureau is assigned on the basis of its technical specialization and availability. When the military and the chief designer agree on the basic system to be developed, the designer formulates the program plan, identifying prospective subcontractor participation, program schedules, and certain capital expenditure costs. The VPK oversees the preparation of decision documents detailing participants, schedules, and specific costs; disagreements are ironed out before the documents go to the Politburo and Council of Ministers for endorsement. Contracts are concluded between the main armaments directorate responsible for the type of weapon system involved (representing the military customer) and the lead design bureau. Funding, materials allocations, and general production targets are then fed into the next five-year plan, with the designation of precise delivery dates left for annual plans.

PLANNERS FACE TOO LARGE A TASK

Ironically, a major problem of the Soviet centrally planned system has been its inability to plan enough. The system lacks the technological entrepreneurs who in the West respond to new market opportunities without being directed—the self-generating "Silicon Valley" microelectronics industrialists. It relies instead on its planners' having sufficient vision and forethought to anticipate the demands of the future. Development by decree tends to focus planning activity on the weapon systems themselves and frequently leads to neglect of support industries. This neglect often means that development of materials and processing technologies lags behind development of system technologies.

The deficiency of detailed plans—for the use of labor, materials, and new technology, for example—leads to problems in production as well. Standard indicators, such as percentage of plan fulfillment or actual output levels, are used to judge performance and award bonuses. As in the rest of the Soviet economy, such simplistic criteria have caused distortions and inefficiencies in Soviet industry as managers seek to maintain output, and thus protect their record of success and bonuses.

IV. Design and Development

The rapid advance of world military technologies over the past decade has greatly complicated the demands placed on Soviet weapon designers. The designers must create weaponry sophisticated enough to perform multiple missions and otherwise exhibit greater capabilities than older weapons, while keeping in mind the limitations of the production base from which the systems must flow.

Soviet weapons have historically reflected a commitment to functional designs that can be readily manufactured in labor-intensive factories and readily maintained in the field with a minimum of technical skill. Designers working for defense industry have not faced the same degree of competitive pressure that drives Western designers to press the state of the art. Rather, they have been required to adhere to industry standards, use off-the-shelf compo-

nents, and employ the preferred design and manufacturing methods detailed in official design handbooks. This approach is intended to ensure producibility, maintainability, and ease of operation.

One reason for the success of Soviet weapon programs has been a low-risk development style. The Soviet emphasis on strict adherence to design and development schedules encourages technological conservatism on the part of designers once a decision has been made to proceed with the development of a weapon, thus ensuring a high probability of development success. This practice carries the potential for obsolescence in the resulting weapon systems, which the leadership tries to offset with almost routine approval of subsequent improvement programs.

Another reason for the success of Soviet weapon programs has been the continuity of personnel in the key development organizations. In contrast to acquisition in the United States, where program managers and other key personnel change frequently, individuals and organizations assigned to that program in the USSR normally stay with it from inception to completion. Moreover, the organizations responsible for the initial version of a weapon are usually responsible for all follow-on versions.

DESIGNERS PLAY KEY ROLE

Soviet weapon designers are charged with broad responsibilities for weapon development programs. Their key role derives from Stalin's approach to developing successful weapon systems—identify an innovative engineer with a strong "can do" attitude, grant him broad authority, and give him the necessary resources. With this authority, of course, went accountability, and more than a few designers in Stalin's time found themselves disgraced or imprisoned as a result of failures. Designers who succeeded during World War II in developing modern weapons from the impoverished technological base carved out empires that still bear their names. Their successes brought fame, professional honors, elite status, and, in some cases, high political rank.

This approach continues. Key weapon designers—designated general designers in the case of major systems and chief designers for other systems and major subsystems—and their bureaus are still given broad authority. Their responsibilities and those of subordinate organizations (subcontractors) are spelled out in party-government decrees authorizing weapon programs, and they are held legally accountable for fulfillment of the decrees. The Soviet system relies on the weapon designer to cope with a science and technology base that, in many areas, is less advanced than the West; to create advanced weapon capabilities using comparatively inefficient production technologies; and to manipulate the bureaucracy in order to get the job done.

DESIGN PROCESS MINIMIZES DEVELOPMENT RISK

On the basis of long-range forecasts of anticipated threats, military planners—in concert with design centers and research institutes—project the weapon technologies required to meet such threats. Thus, weapon advances in the USSR result more from a requirements "pull" than a technology "push."

Emerging technologies are proven in applied research, a process usually distinct from the development of actual weapons. Success in applied research may enable the designer to include a new technology—or an adaptation of an existing technology—in new weapon systems with little risk of failure. For example, even the development of a new weapon that incorporated a major technological advance—the SS–17 MOD 1, the first Soviet ICBM capable of carrying multiple independently targetable reentry vehicles (MIRVs)—need not have involved much risk. MIRV technology had been worked out in applied research for several years before its introduction into that system.

Thus, by the time Soviet weapon programs are formally authorized, the key technologies necessary to meet the proposed performance specifications and program obligations are generally well understood, if not in hand. Bonuses are keyed to successful program completion, and penalties can be levied for failure to achieve the stated goals. This emphasis on schedules gives the integrating designer and subcontractors an added incentive to include in the weapon's development only those devices, components, or materials known to be producible or adaptable within the given time constraints. The result is a de facto technology freeze on major system components before the weapon is developed.

Because of the emphasis on incorporating only trusted technologies in new weapons, Soviet designers are inclined to employ entire subsystems from previous generations of weapons. This practice allows the Soviets to continue using older equipment efficiently, because the parts for newer systems can be used in older systems as well. Fewer types of weapon components and spares need to be kept in inventories for maintenance and repair.

ADVANCING THROUGH MODULAR UPGRADES

The Soviets commonly offset some of the drawbacks of the early technology freeze with subsequent improvement programs, using approaches and technologies that became available during the previous program. As a result, major design bureaus are often simultaneously working on new and modernized weapon systems in different stages of development. The Soviets pursue a three-track approach to stave off the technological obsolescence that could result from the early freeze:

- —They frequently introduce modular upgrades for fielded systems. Such upgrades minimize design changes and are typically limited to one or a few components. (Some of the alterations can be done by military repair bases in the field.)
- —They modernize systems more thoroughly by improving one or several major subsystems, such as missile guidance or aircraft avionics.
- —Their most ambitious option is to introduce major modernizations or entirely new systems.

A classic example of a system incorporating all these options is the T–64 tank. The initial variant of the T–64 featured several new tank components and subsystems, including the engine, turret, and transmission. The T–64A was equipped with a new 125-mm gun system, but it probably did not require a major change in manufac-

turing technology. The much-improved T-64B incorporated a new laser fire-control system and is capable of firing both antitank guided missiles (ATGMs) and 125-mm ammunition. The fire-control system probably required modern electro-optics similar to those found in modern Soviet ATGMs.

In addition to allowing the incorporation of new technologies more quickly than if a new weapon system were started from scratch, modular upgrading helps hold down the cost growth involved in continually developing new systems. Manufacture is also easier, as modernized systems can frequently be produced on the same production lines that produced their predecessors. Finally, modular upgrades, because they do not call for major changes in resource or supplier networks, enhance the continuity of centralized planning and are thus easier for Soviet planners to cope with.

WESTERN TECHNOLOGY CUTS TIME AND COSTS

Soviet planners use Western technologies as a yardstick to evaluate their own capabilities. They also try to take advantage of basic research undertaken by Western engineers and, with some important exceptions, pursue technologies already proven in the West. The Soviets have a well-organized national program for the overt and clandestine acquisition and assimilation of Western—primarily US—technology. Key research institutes and primary design bureaus make long-range forecasts of critical technologies that they anticipate will be required in future weapon developments. A VPK-led commission gathers, edits, and assigns collection requirements for the acquisition of Western technology through legal and illegal means.[6]

Technologies and engineering know-how acquired from the West have allowed the Soviets to strengthen their capabilities significantly in many areas basic to the development of modern military systems, particularly in the fields of microelectronics and computers. Incorporating the results of Western technology instead of relying wholly on domestic R&D capabilities yields significant savings in program costs, frees indigenous R&D resources for other uses, and allows earlier development of weapon systems. Because the Soviet procurement system emphasizes incremental improvement programs more than the US system does, the acquisition of Western equipment helps the Soviets to field upgraded weapons more quickly.

DESIGN SIMPLICITY ASSURES PRODUCIBILITY

Western analysts have often characterized Soviet weapon systems as "simple, rugged, and easy to maintain." Rigorous design specifications—such as mirror-like finishes and tight tolerances—are called for only where necessary for performance. Circuit designs are simple by US standards, and materials that are costly and difficult to machine are avoided where possible (titanium-hulled submarines are an important exception). Soviet designers have also developed a knack for keeping parts to a minimum. For

[6] See US Department of Defense report, *Soviet Acquisition of Militarily Significant Western Technology: An Update*, September 1985.

example, the R-11 engine, which powers the widely deployed Fishbed MIG-21, contains significantly fewer parts than the roughly comparable J-79 engine, which powers the US F-4.

The simplicity (relative to Western standards) chosen by Soviet designers has entailed trade-offs. Design simplicity increases reliability and reduces development and production costs. It has allowed the production of capable weapons by a labor-intensive industrial base without substantial investment in new manufacturing methods. The choice of a simple design, however, has frequently resulted in a less sophisticated weapon, often restricted in application to a single military mission.

Simplicity also poses trade-offs in terms of maintenance. Most Soviet subsystems have a shorter service life than those in the West, resulting in a greater burden of maintenance, component replacement, and repair. Thus, in Soviet logistics a large number of spare systems are in the maintenance pipeline at all times, and large numbers of technicians have to be available to do the frequent routine maintenance tasks. They perform only the simplest of maintenance tasks in the field; weapons and weapon components are returned frequently to the plant or major maintenance depots for repair and overhaul. Despite the seeming inefficiency of this practice, it probably reflects a policy chosen by the Soviets because of the low skill level of their conscript force. The simpler maintenance demands on troops are also attractive to Soviet clients in the Third World, where technical skills are at a premium.

WESTERN TECHNOLOGIES FORCING CHANGE

Although it has served the Soviets well for decades, the traditional Soviet design strategy does not appear well suited for some key challenges of modern technological environment. A greater commitment to developing and manufacturing more complex weapon systems will probably become necessary as the Soviet strive to counter many of the new capabilities of Western armaments. In addition, the mission flexibility and lower total procurement levels made possible by advanced, multipurpose systems may be the most rational solutions to soaring weapon costs—despite the higher per-unit price tags.

A change in design strategy appears to be under way but is proving painful and slow. Translating new technologies into capabilities more quickly, for instance, means altering the traditional practice of perfecting them in applied research first. Because of this, some new weapons are proving difficult to assimilate into production. In the field, the operation and maintenance of extremely sensitive electronics and other advanced systems are being entrusted to a force of largely unskilled conscripts. Nonetheless, the appearance in the 1970s of several new, more complex systems designed to accomplish multiple missions—such as the SU-27 interceptor aircraft and the SA-10 surface-to-air missile—illustrates the evolution in procurement policy already under way.

V. Production

The Soviet weapons industry has traditionally relied on the extensive growth of the economy to expand weapon production,

giving priority to weapon producers in the allocation of scarce resources. The slower growth of the Soviet economy in the past decade, however, has led the Soviet leaders to stress efficiency more than in the past. At the same time, dramatic improvements in Western weapons have led them to stress greater advances in weapon technology. To meet both these requirements, in the 1970's the Soviets stepped up the modernization of their production base, devoting a great deal of attention to the introduction of the latest machine tools and other advanced manufacturing equipment.

STALINIST LEGACIES

The Soviet industrial base for armaments production continues to bear features typical of the Stalinist industrialization. Institutional continuities—such as a centralized and unified executive structure, long-term ties between cooperating enterprises, and plants producing the same product line for over half a century—assist Soviet industry in manufacturing weapon systems rapidly and in large numbers.

Production is usually concentrated in large plants, some of which are parts of multipurpose facilities. Soviet production facilities are generally much larger than those producing similar items in the United States, mainly because the Soviets frequently colocate plants producing components for the same system. Similarly, support industries are frequently colocated with final assembly facilities. This sort of vertical integration has been employed over the decades as a hedge against the inefficiency of the Soviet transportation and supply network and the vagaries of central planning.

Labor has traditionally been treated in the Soviet economy as an inexhaustible commodity. This is partially the result of the Soviet policy of full employment, which has the added benefit of ensuring a high state of readiness to expand production in case of war. This has led to its relatively inefficient use, particularly in the extremely labor-intensive machine-building sector. Large numbers of unskilled or semiskilled workers are employed to operate such relatively simple tools as lathes, milling machines, and boring and broaching equipment. This inefficiency has been aggravated by the weakness of incentives to economize on labor and by indifferent labor discipline—poor attendance, high rates of alcoholism, and theft from the shop floor. As the number of youths joining the Soviet labor force decreases, however, the Soviet leadership is seeking to increase their effectiveness by experimenting with new forms of shop-floor labor organization and embarking on discipline campaigns.

AGING FACTORIES

Visitors to Soviet production plants have noted outdated manufacturing equipment, some from the World War II period. Soviet managers typically do not replace equipment until it is worn out, rather than when it becomes obsolete, as is more typical in the West, and they sequester and stockpile replacement equipment. Even when new equipment is installed, plant managers have tended to keep the older equipment as a backup. These practices

dilute the effectiveness of capital investment, especially reducing its impact on productivity.

Managers have typically not replaced equipment because it disrupts operations. Assimilating new equipment causes downtime, which the central planners do not always allow for by lowering the plant's production targets for the period involved. Soviet enterprise managers reportedly also do not trust new equipment to work well. A new production process makes them dependent on outside experts and on new suppliers of components and services, such as software support. Another factor limiting the willingness of managers to modernize is the relatively narrow selection of technologies and equipment from which they have to choose. For example, although the USSR produces more conventional and numerically controlled machine tools than any other country, many of them are general purpose machine tools that are relatively easy to produce in large quantities rather than special-purpose and complex types.

VARIATION IN PRODUCTION PROCESSES

The industrialization drive of the late 1920's and early 1930's and the Stalinist system combined to create a mosaic of industrial technologies. The scarcity of capital led Soviet authorities to ration it; and even today, in many Soviet plants, state-of-the-art equipment works in tandem with primitive, labor-intensive operations. An individual plant tends to develop unique production processes as its managers grab equipment whenever and wherever they can get it and as the relative lack of competitive pressure enables plants to operate at widely varying levels of efficiency. Variations among industries tend to impede the diffusion of new technologies, as managers may find that advanced equipment developed elsewhere is technically incompatible with their operations.

These considerations, along with the differences in their R&D capabilities, have led the Soviets to approach basic manufacturing operations in a way different from that prevailing in US industry. For example, Soviet manufacturers seek to minimize the use of machining in the production of weapons to a greater extent than their US counterparts. They attempt to use net-shape-forming techniques (casting, forging, powder metallurgy, and extrusion), which—although more labor intensive and time consuming than machining in the United States—eliminates the need for complex manufacturing machinery. The USSR has managed to stay abreast of the West in net-shape forming, and in some processes—such as titanium casting—it has surpassed the West.

The Soviets also rely more on welding than on the mechanical fastening techniques preferred in the West. In the aircraft industry, for example, US manufacturers prefer fasteners such as rivets because they tend to provide greater structural integrity than welds and because repair is less labor intensive. (Repair of welded systems requires cutting and rewelding.) The power of Soviet weapon designers is illustrated by their ability to make individual choices in matters of this kind. For joining fighter aircraft components, for instance, the late designer Pavel Sukhoy generally preferred rivetting, while the late Artem Mikoyan preferred welding.

DRIVE TO MODERNIZE

The Soviet leadership, recognizing that the production of more advanced weapons would place increased demands on the manufacturing base, accelerated efforts to modernize defense plants in the early 1970's. In many plants the Soviets have installed new types of equipment and are emphasizing the development and use of labor-saving automated machinery. Other measures include the revision of incentives for managers to promote recapitalization; the use of systems planning; expanded training and employment of specialists in such fields as machinery automation; and construction of new types of facilities to house modern, integrated manufacturing lines.

Substantial improvement in the average level of manufacturing technology appears to have taken place throughout most of the defense industries. The high rate of expansion of defense industry facilities—which in the Soviet Union is usually accompanied by the installation of new manufacturing equipment—suggests that increasingly advanced equipment is being employed in many production lines. Soviet literature describes efforts to economize on labor with automated equipment in such labor-intensive production operations as shipbuilding.

PROBLEMS WITH NEW TECHNOLOGIES

Despite these advances, the weapons industry has been hampered by lags in support industries. The technologies required to build advanced systems are precisely those where Soviet R&D and production capabilities are weakest—electronics (including microelectronics), advanced high-speed computers, and sophisticated design and manufacturing systems. The real revolution in Western manufacturing technology—the marriage of precision machine tools and microelectronics—has not fully reached the Soviet civilian or defense industries despite recent leadership efforts.

The gains in recent years in Western manufacturing productivity from the introduction of computer-controlled production processes and computer-aided automation of specialized equipment, therefore, have not been matched in the Soviet Union. The measured success the Soviets have enjoyed thus far in developing mainframe computers has resulted largely from copying Western—especially US—developments. Even this has not come easily: Soviet engineers took longer to copy the IBM System/360 than IBM took to develop it in the first place. Furthermore, because manufacturing equipment in some weapons industries—such as the aviation industry—now reaches technological obsolescence in an average of less than 10 years, such rapid changes in technology particularly challenge the Soviets, who keep many conventional machine tools in production long after they reach their obsolescence.

Thus, although the Soviets have devoted considerable resources to the development of manufacturing technologies, they have not been able to keep pace with the West. Several factors have hampered Soviet development:

—Excessive compartmentation due to secrecy.

—Lack of innovation-promoting incentives.

—A late start in the use of computer-aided design and development equipment to create microelectronics.
—An underdeveloped network of software, service, and components support.
—Insufficient training for potential users.
—Resistance by managers who distrust new systems and are unenthusiastic about the increased accountability provided by computers.
—A bureaucratic managerial structure that impedes rather than facilitates scientific-industrial interaction and cooperation.

IMPORTS OF FOREIGN MANUFACTURING TECHNOLOGY

Deficiencies in many of the manufacturing technologies necessary to modernize their armaments plants and other plants have prompted the Soviets to emphasize legal and illegal acquisitions. The Soviets also buy a substantial volume of these products from Eastern Europe, even though they are less advanced than those purchased from the West.

Although the Soviets reap substantial benefits from imported technology, they frequently have problems assimilating it into production. These difficulties are sometimes greater when the technology is illegally acquired, because in those cases Soviet engineers usually cannot benefit from foreign training and technical assistance. Modern critical technologies and equipment are generally more difficult to transfer—and much more difficult to duplicate by reverse engineering—than those that contributed to earlier Soviet industrial development.

VI. Prospects

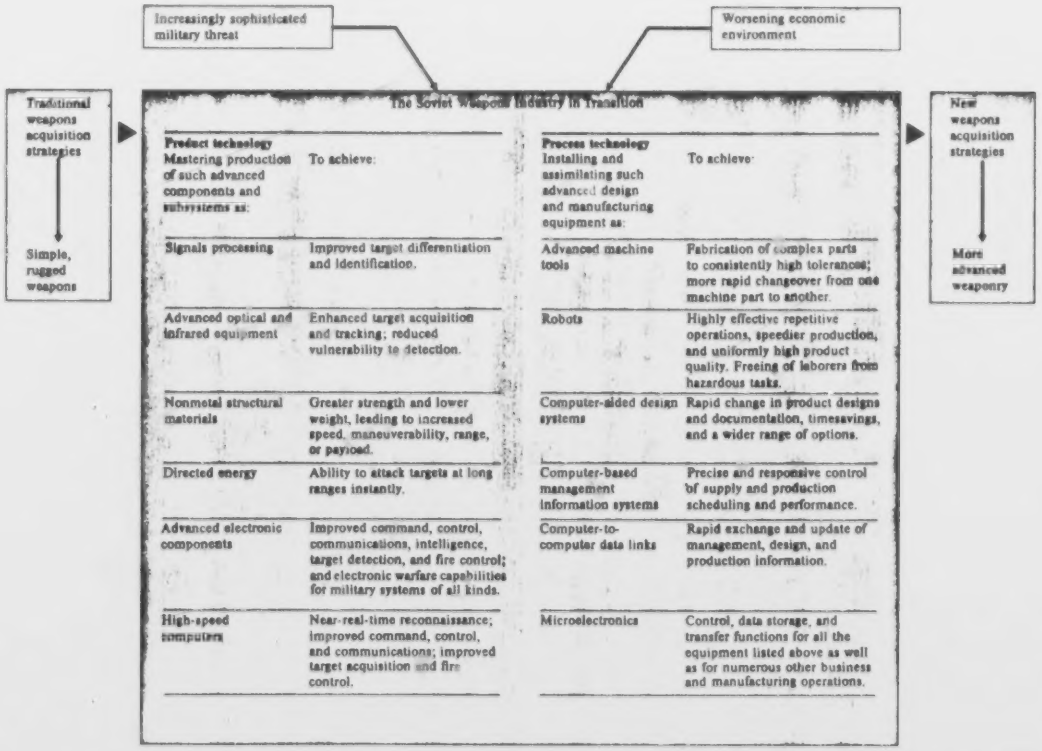
In the decade ahead the Soviet weapons industry will face the challenge of meeting increasingly complex military requirements at a cost acceptable to the Soviet leadership. Many of the problems it faces, and their solutions, are unique to the defense industries. Nevertheless, they will have repercussions throughout the Soviet military and economy.

THE SEARCH FOR A NEW PRODUCTION STRATEGY

As already noted, the Soviet defense industries have traditionally followed a simple strategy, capitalizing on the high priority given to defense, taking advantage of inherent Soviet strengths, and seeking to negate Soviet weaknesses. Soviet society has shouldered a high defense burden, churning out large quantities of weapons at the sacrifice of more rapid economic growth and higher standards of living. The military's requirement for large quantities of weapons has both enabled and encouraged the defense industries to emphasize simplicity, producibility, and ease of maintenance, thereby mitigating the handicaps of a relatively low-skilled industrial and military labor pool and a technologically stunted industrial base.

FIGURE 7

Changing Conditions Affecting the Soviet Weapons Industry


Increasingly sophisticated military threat
Worsening economic environment
Traditional weapons acquisition strategies
Simple, rugged weapons
The Soviet Weapons Industry in Transition
Product technology
Mastering production of such advanced components and subsystems as:
To achieve:
Signals processing
Improved target differentiation and identification.
Advanced optical and infrared equipment
Enhanced target acquisition and tracking; reduced vulnerability to detection.
Nonmetal structural materials
Greater strength and lower weight, leading to increased speed, maneuverability, range, or payload.
Directed energy
Ability to attack targets at long ranges instantly.
Advanced electronic components
Improved command, control, communications, intelligence, target detection, and fire control; and electronic warfare capabilities for military systems of all kinds.
High-speed computers
Near-real-time reconnaissance; improved command, control, and communications; improved target acquisition and fire control.
Process technology
Installing and assimilating such advanced design and manufacturing equipment as:
To achieve:
Advanced machine tools
Fabrication of complex parts to consistently high tolerances; more rapid changeover from one machine part to another.
Robots
Highly effective repetitive operations, speedier production, and uniformly high product quality. Freeing of laborers from hazardous tasks.
Computer-aided design systems
Rapid change in product designs and documentation, timesavings, and a wider range of options.
Computer-based management information systems
Precise and responsive control of supply and production scheduling and performance.
Computer-to-computer data links
Rapid exchange and update of management, design, and production information.
Microelectronics
Control, data storage, and transfer functions for all the equipment listed above as well as for numerous other business and manufacturing operations.
New weapons acquisition strategies
More advanced weaponry

Since the late 1960's, changes have taken place—strains in the domestic economy, expanding military technology frontiers, and improving foreign military capabilities—that are undermining the effectiveness of the traditional strategy. To cope with the new conditions, the Soviet leadership is changing its weapon acquisition policies and the infrastructure and operating practices of the defense industries. The following changes appear to be taking place:

—*In resource allocation, a more sophisticated evaluation of the priority accorded the defense industries.*—Defense will continue to have a high priority, but the increasing costs and complexity of producing advanced weapons are inducing leaders and planners to seek more cost-effective ways to meet military requirements. They are less likely than before to give their relatively insular weapons industry first access to the trough by rubberstamping its requests for material and manpower and then dividing the remainder among other claimants. In addition, Soviet writings and statements indicate recognition in party, government, and military leadership circles that long-term Soviet defense needs will require balanced development among industry, services, and the technology base.

—*In weapons development, a shift from highly conservative to more advanced applications of technology and from simple to more complex weapon designs where necessary to achieve desired weapon capabilities and performance.*—Opportunities for using clever designs in place of sophisticated technology will diminish, although the Soviets will continue to rely on traditional approaches in most cases. Weapon designers will have to adapt to the new capabilities provided by computer-aided design and manufacture, which are already an essential part of the weapon-design process in the West.

—*In production, the manufacture of advanced weapons in smaller quantities and at lower rates.*—Improved performance and a wider range of capabilities for new weapons—along with higher unit procurement costs, greater production problems, and more costly operational and maintenance requirements for modern manufacturing equipment—are likely to discourage the Soviets from manufacturing many advanced weapons at past rates. The danger of obsolescence (given today's rapidly changing threat and military technology base) will also encourage shorter production runs. For the same reasons, the Soviets may begin to produce fewer types of weapons. The Soviets have also embarked on retrofit programs designed to ensure the combat worthiness of their older systems, as in the case of older tanks and fighter aircraft intended for export or deployment in areas away from the frontline.

—*In the industrial base, more rapid growth in the high-technology support sectors of the weapons industry—radioelectronics, telecommunications, specialty materials, and advanced production equipment—than in weapon and equipment producers.*—Throughout the defense industries, the Soviets will press for renovating and modernizing established facilities instead of constructing new plants, and they are redirecting

investment to increase the availability of equipment and tooling.

—*In administration, limited changes in planning and management practice.*—The Soviets have begun to revise plan targets, prices, and incentives to encourage innovation and favor quality over quantity. The defense industries will continue, however, to be the most thoroughly scrutinized part of the Soviet economy, subject to management by decree.

—*In seeking help from abroad, stress on the buildup of the scientific-technical base of the East European allies and relying on them more to fill some of the USSR's high-technology needs.*—The Soviets will continue, however, to rely on imports of technology and equipment from the West as well.

Other changes we expect to see include even greater attention to quality control and an emphasis on reeducating the work force. These will become increasingly important as weapon systems incorporate more complex devices, components, and subassemblies. Increasing demands will be levied on the military and industry to find, train, and retain sufficient numbers of engineers particularly knowledgeable about production technology.

CHANGES IN THE MILITARY

Changes in the Soviet armed forces in the 1990's will drive—and be driven by—the changes in weapons technology and the Soviet strategy for weapons acquisition. Alterations in doctrine, force structure, logistic organization, maintenance requirements, and manpower use are likely to ensue.

The advent of new weaponry embodying advanced technologies—in both Soviet and enemy forces—will probably lead to some adjustments in Soviet military doctrine. The Soviets will probably intensify their efforts to develop tactical and organizational concepts that exploit the combat effectiveness of a force combining fewer but more capable new systems with large numbers of older systems. Force structure may also change in some instances to accommodate different numbers and missions of new weapons. In a few cases, the long-term impact of acquiring increasingly sophisticated weapons may be a reduction in total numbers maintained in active inventories. Overall force effectiveness will increase as the mobility, survivability, and lethality of weapons improve.

Logistic support will have to be revamped to fit the force of the future. Increasingly complex weapons probably will require a larger support establishment as well as changes in the traditional Soviet maintenance philosophy. The weapons industry will be required to deliver considerably larger quantities of maintenance spares to military depots, and troops may begin to take more responsibility for diagnostic work.

The new weaponry's greater requirements for skilled operators and maintenance crews will test the creativity of military manpower and training authorities. The 1982 extension of military recruitment for some job categories to include women is one sign that the Soviets are aware of this problem. Requirements for longer training times and more advanced skills could lead the Soviets to in-

crease the period of service for conscripts serving in highly technical specialities.

Finally, the higher costs of weapons will probably lead the military to cut costs elsewhere. Articles have appeared in the Soviet press urging the military to economize wherever possible, and other articles have illustrated that it is trying to comply. The introduction of new forms of work organization, more careful use of supplies, and better accounting and internal planning procedures are all designed to cut the fat from military expenditures in the face of growing procurement costs.

CHANGES IN THE ECONOMY TO INCREASE DEFENSE POTENTIAL

In the last years of the Brezhnev era, the Soviets began to map out a strategy to speed the modernization of both the civilian and the defense industries. The focus has been on a "high-technology revolution" and a revitalization of the entire industrial base. The leadership under Gorbachev has moved to reinforce the place of scientific and technological progress as the linchpin of its economic strategy.

Although the defense industrial ministries have had special status, they have never been completely insulated from civilian industry—an indispensable supplier of materials, components, and subassemblies—and the lines between the two sectors are becoming increasingly blurred. Soviet leadership has recognized the increasing interdependence of the civilian and defense sectors and is seeking ways to lower the barriers of secrecy and bureaucracy between them.

Furthermore, after nearly 20 years of unprecedented stability, the bureaucratic elite that oversees the Soviet economy is undergoing significant change. General Secretary Andropov initiated the process of rejuvenating both party and government bureaucracies with new faces, and it has continued with a vengeance under Gorbachev. Only three of the nine current defense industry ministers, for example, held the same positions five years ago. Many of the new managers are better educated and more familiar with the requirements of high technology than their predecessors—and have been strong public advocates of industrial efficiency and modernization. The Soviet leadership is also tapping managers from the weapons industry to serve throughout the economy, hoping to take advantage of their managerial talents in the civil arena.

DEFENSE INDUSTRIES IN THE 1990'S

Despite all the reforms under way, the Soviet defense industries face a great many challenges in their mission to produce enough highly advanced weapons for the forces of the next decade. They are already experiencing problems with several advanced systems. Expansion in high-technology-related industries, advances in precision machining and other fabrication technologies, and continued aggressive exploitation of Western technology suggest that the Soviets will overcome some of the difficulties with which they are currently struggling. Nevertheless, the underlying major deficiencies—particularly the lack of support service industries, inflexible plans, bureaucratic inefficiencies, and excessive secrecy—are likely

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to persist. Success will depend in large part on Gorbachev's ability to stimulate innovation and increase productivity throughout the economy. Tension between current and future military requirements will also influence the outcome.

On the other hand, some factors will help the weapons industry satisfy future military requirements. Because there is frequently a lag between technological advances and resulting improvements in military capabilities in the West, Soviet designers often succeed in incorporating generic equivalents of Western technologies (sometimes stolen) into their own systems as quickly as, or more quickly than, their Western counterparts. Also, the Soviets will probably be able to continue to surge ahead along a narrow front of military technologies because their centrally planned system allows them to place more emphasis on those areas than the West does. Finally, where the Soviet military experiences shortcomings in weapon capabilities, it will continue to compensate with large numbers of weapons with complementary strategies and tactics.

In any event, the weapons industry will continue to be a vital ingredient in Soviet military power, which has been the primary instrument of the leadership in achieving national security, political leverage, and prestige throughout the world. The weapons industry will be at the forefront of Soviet technology and industrial prowess and will continue to absorb a large share of available resources. Its leaders will continue to wield considerable influence on Soviet policy. And—with the combination of growing economic constraints and the increasing potential and challenges afforded by advancing military technology—the performance of the weapons industry may well be an even greater determinant of Soviet military power than it is today.

ESTIMATING SOVIET MILITARY HARDWARE PURCHASES: THE "RESIDUAL" APPROACH

By Bonnie K. Matosich*

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SUMMARY

It has long been accepted that the Soviet machine-building and metalworking (MBMW) sector is the source of almost all military hardware—as well as machinery for consumption, investment, and capital repair. When the Soviets report data on MBMW output and on the distribution of this output, however, they do not provide information on the military's share. The secrecy surrounding this information has led many Western analysts to attempt to estimate the share from reported Soviet economic data.

One appealing estimating technique is known as the machinery purchases "residual" approach. The basic assumption of this approach is that all military machinery purchases are included in the MBMW output data, but not in reported purchases. Using this method, analysts subtract the value of identifiable nondefense purchases from the total output of the MBMW sector. The remaining output—the residual—is believed to represent the value of annual purchases of military hardware.

We have conducted a lengthy investigation of this approach. In this report, we present the results of our attempt to estimate a machinery purchases residual for the years 1966 through 1985. To derive the estimate, we reviewed the available evidence on MBMW output and the estimating techniques used in previous attempts to apply the residual approach. At each step, we calculated the uncertainties resulting from various interpretations of the data.

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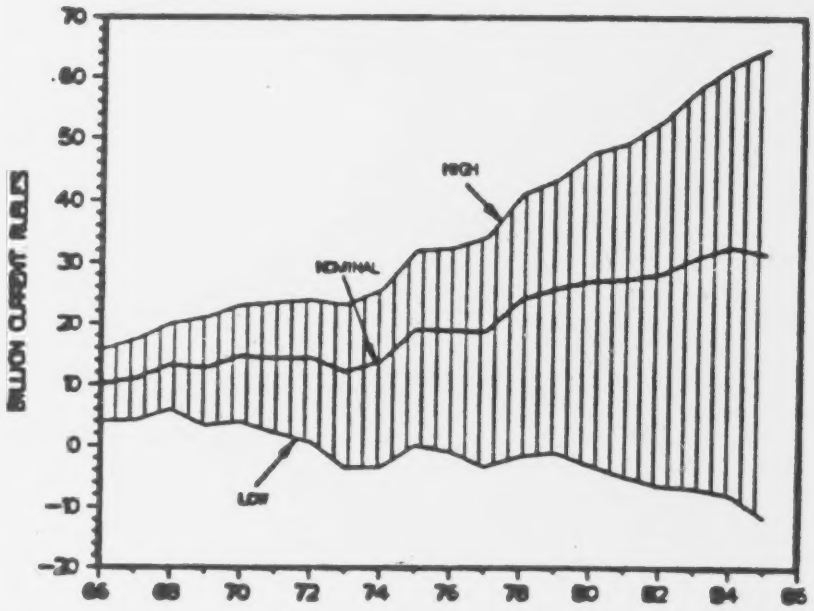
Because of the great uncertainties associated with the interpretation of the Soviet data used in the residual procedure, we conclude that our approach and two independent methods that were also examined are unreliable as independent techniques for estimating the level and trend of Soviet military hardware expenditures. For example, the estimates for the total value of machinery produced—the starting point for each of the techniques examined—range from 170 billion rubles to 191 billion rubles in 1980.

The data used in the remaining steps in the analysis are incomplete, poorly defined, and incomparable in price base and coverage. To estimate the various categories of nondefense production using these data, for example, many assumptions must be made that, cumulatively, lead to considerable variation in the final estimate. In particular, very little data have been available on the purchases of machinery—regardless of whether the military or civilian sectors purchase these goods—since 1972. To produce figures for recent years, we must estimate values for many of the key variables. The tremendous range in both the levels and growth rates of residual estimates does not necessarily mean that the methods are wrong. But they do illustrate a problem inherent in the approach—that various assumptions and methods used in developing the estimates can cause widely differing results.

The degree of uncertainty in an estimate of military machinery purchases calculated by the residual method becomes readily apparent in an analysis of our results. In current prices they suggest a wide range in estimates of military purchases—between 4 billion and 16 billion rubles of machinery in 1966 and between −12 billion and 65 billion rubles of machinery in 1985. Between those years, the high estimate grew an average of almost 8 percent a year, while the low estimate declined. The "nominal" estimate—for most steps this is the mean—grew approximately 7 percent annually, increasing from 10 billion rubles in 1966 to about 32 billion rubles in 1985. Military machinery purchases measured in 1970 comparable prices—the Soviet version of constant prices, which includes considerable inflation—grew slightly faster than those in current prices; the range of uncertainty was about the same.

Residual Estimate of Soviet Military Machinery Purchases



Our low estimate of military machinery purchases in current prices actually fell below zero for several years—an intriguing finding since even the low estimate includes not only residual machinery purchases (any that are not specifically accounted for), but also a portion of the reported "civilian" machinery purchases. Therefore, the basic premise of machinery residual analysis—that all military machinery purchases are included in the MBMW data but not in reported purchases—may not be true. In our nominal estimate, a strict accounting of all civilian purchases of MBMW output exhausts the total, and virtually no residual remains. This suggests two possibilities:

—Some or all military purchases are included in MBMW gross value of output (GVO) figures but are not hidden in the data as a residual. Rather, they are distributed among various categories of "civilian" purchases.

—Some or all purchases of military hardware are excluded from data on MBMW GVO as well as from reported purchases of MBMW output.

An analysis of these data alone does not provide an indication of which hypothesis is true. Because we cannot estimate what portion of military hardware purchases we capture in a residual estimate, the technique has little usefulness as an analytical tool.

Even if we were to obtain better definitions of the content of the Soviet statistics, other problems with the data greatly reduce the value of the results. For example, even when residuals can be estimated, their levels and trends are distorted by hidden inflation in the MBMW sector. Official indexes of comparable prices published by the Soviets understate inflation, leading to an overstatement of growth of real output. As a result, we are unable to distinguish be-

tween real and inflationary growth in the Soviet MBMW sector using published statistics.

The Appeal of a Residual

Each year, the USSR publishes data on defense spending in *Narodnoye khozyaystvo SSSR (The National Economy of the USSR,* hereinafter referred to as the *Narkhoz).* The *Narkhoz* reports annual spending in current prices, including a single line item for the defense budget. Since 1969, this figure has been reported within the range of 17-20 billion rubles—a level inconsistent with the known expansion of Soviet military programs and Western estimates of their annual costs.

In addition to the figures reported for defense spending, the *Narkhoz* contains data on industrial production. The subtotals of the various output reported for each sector of industry, however, often add to less than the reported total production of that sector. The fact that some output is not specifically accounted for has convinced many Western observers that the production of weapons is hidden in the data.

Several different approaches have been developed to isolate military items in the data. One of these methods, known as the machinery purchases "residual" approach, separates reported data on purchases of the output of the machine-building and metalworking (MBMW) sector into purchases intended for military and civilian uses.[1] This method focuses on the MBMW sector because, of the 11 major branches of industry in the Soviet Union, it is believed to produce almost all military hardware. Isolating military purchases first requires identifying civilian purchases of machinery and other nondefense production in the published production figures. In theory, the value of machinery allocated to the military—the residual—can be calculated by subtracting the value of all nondefense production from the total.

Estimating military hardware purchases in this manner is appealing because of its apparent simplicity. The approach requires little time and money for research, as it relies almost entirely on published information. Its value depends primarily on whether the necessary pieces of data can be collected, organized properly, and interpreted correctly.

This report describes the complications involved in developing a residual estimate and evaluates the utility of the technique for estimating Soviet outlays for military hardware. It discusses the CIA residual methodology and estimates and compares them with those developed by William T. Lee and the Defense Intelligence Agency (DIA).[2] To assess the contributions that the residual approach can make to research on Soviet military spending, we examine possible sources of uncertainty and their effect on the residual estimates.

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[1] Other residual approaches, such as those which examine Soviet budgetary data and national economic balance tables, are not examined in this study.

[2] William T. Lee, *The Estimation of Soviet Defense Expenditures, 1977-75: An Unconventional Approach* (New York: Praeger, 1977). Lee is now employed by DIA; this paper presents his work and that of DIA prior to his employment with that agency.

The CIA Residual Estimates

Western efforts to isolate military machinery production by the residual approach date back to the mid-1950s. Many individuals and organizations—including Lee, Robert Campbell, Stanley Cohn, Michael Boretsky, the Rand Corporation, Stanford Research Institute, Wharton Econometrics, DIA, and CIA—have examined published Soviet machinery statistics in an attempt to isolate defense costs. The CIA's residual analysis presented here owes much to prior research. Despite wide differences in detailed calculations and results, we followed the same basic steps as previous methodologies. In some cases, we adopted features of earlier work, with explicit recognition of the uncertainties; in other instances, we relied on our own alternative estimating techniques.

BUILDING AN ESTIMATE

Soviet statistics on machinery output do not permit straightforward determination of a machinery purchases residual. The isolation of military hardware purchases requires several steps that are outlined for a single year in figure 1. Because of the numerous adjustments necessary at each step, the process is long and tedious. For this reason, the calculations are explained only generally in this paper. For an appendix providing a detailed explanation of the various steps and the corresponding tables, contact the author at the Office of Soviet Analysis, Central Intelligence Agency.

MBMW output

The estimation of a Soviet military hardware residual starts with the gross value of output (GVO) of the machine-building and metalworking sector, commonly referred to as MBMW GVO. (The glossary explains this and other terms.) The Soviets have reported MBMW GVO—based on slightly lower employment figures than those used in the *Narkhoz*—for several years. We use these reported figures as benchmark estimates to check the trend of our estimated series. To estimate annual ruble values for MBMW GVO, we use three different estimating techniques:

—The first method is based on the reported share of MBMW GVO in industry GVO. These statistics are published in current prices only for 1975 and 1982, allowing us to estimate output for those years only. Therefore, this method is useful primarily for checking estimates for those years derived by other methods.

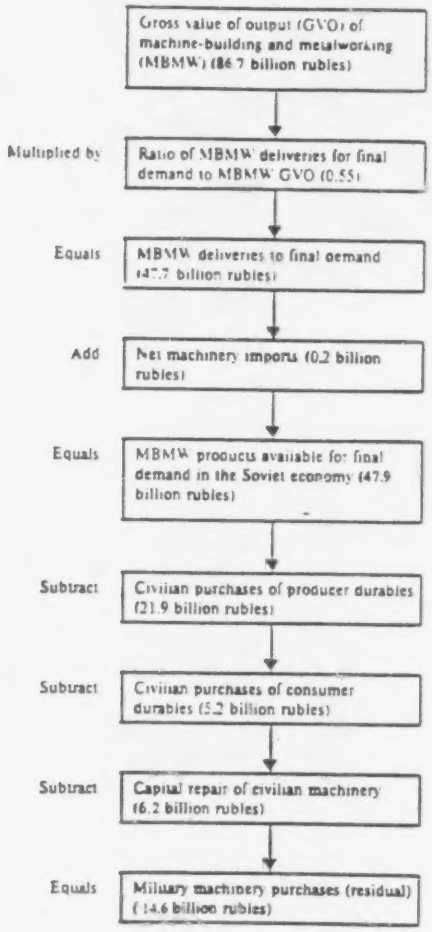
—The second method uses frequently published data on the size and wages of the MBMW labor force. From these data and figures on social insurance deductions and incentive payments, we can calculate total MBMW labor costs. The Soviets publish, as a percentage, the share of labor costs in MBMW production costs, allowing us to calculate the latter. By adding profits to this figure, we derive MBMW GVO. We believe such estimates are fairly accurate; they track closely with the benchmark figures and the values calculated as a share of industry GVO.

—The third method relies on MBMW amortization and capital stock data, which are available for a number of years. The

Soviets publish industry amortization charges, from which we can estimate MBMW amortization charges. In addition, the Soviets report the share of amortization charges in production costs, so we are able to determine MBMW production costs. Then, as in the second method, we add profits to obtain MBMW GVO. This technique produces a complete series of estimates for the years 1966 through 1985.

The second technique produces results that are approximately five percent higher each year than those provided by the other two approaches. Because we cannot explain the difference, we range our estimate of MBMW GVO for 1966–85 between the high and low values produced by the last two techniques.

Figure 1
CIA's Residual Methodology: Nominal Estimate for 1970


Gross value of output (GVO) of machine-building and metalworking (MBMW) (86.7 billion rubles)
Multiplied by
Ratio of MBMW deliveries for final demand to MBMW GVO (0.55)
Equals
MBMW deliveries to final demand (47.7 billion rubles)
Add
Net machinery imports (0.2 billion rubles)
Equals
MBMW products available for final demand in the Soviet economy (47.9 billion rubles)
Subtract
Civilian purchases of producer durables (21.9 billion rubles)
Subtract
Civilian purchases of consumer durables (5.2 billion rubles)
Subtract
Capital repair of civilian machinery (6.2 billion rubles)
Equals
Military machinery purchases (residual) (14.6 billion rubles)

MBMW deliveries to final demand

Because our intent is to calculate the value of final goods delivered, all intermediate goods (those delivered to other producing enterprises) produced must be subtracted from the estimate of total machinery output. The Soviets do not report the value of intermediate products or of MBMW output delivered to final consumers (deliveries to final demand). However, we can calculate the ratio of MBMW deliveries to final demand to MBMW GVO for three years using the 1966 and 1972 Soviet input-output tables (as reconstructed in the West) and the preliminary Western construction of a 1977 input-output table.[3] By interpolating and extrapolating, we estimate ratios for the remaining years in the series. Then, we multiply MBMW GVO for each year by the corresponding ratio to get the value of MBMW deliveries to final demand.

Errors in estimating the value of MBMW intermediate products, a substantial portion of total machinery output, can introduce considerable uncertainty into estimates of deliveries to final demand. Moreover, since the Soviets have not released any information on the relationship between GVO and deliveries to final demand since 1972, ratios for later years are simply estimates.

Net machinery imports

To estimate the value of machinery available to the Soviet economy, all machinery exports must be subtracted from the value of MBMW deliveries to final demand and all machinery imports must be added—or, more simply, net imports must be added.

Net imports for the MBMW sector are derived from published trade data. Total imports and exports for MBMW industries, as for all industrial branches, are reported each year in the *Narkhoz* as a percentage of total trade. Although these data allow the direct calculation of imports and exports for the MBMW industries, the aggregated import and export data for MBMW and the other industrial sectors do not add to the total in the *Narkhoz*. Seven to 15 percent of Soviet trade is not specifically accounted for. We believe that most of this trade residual is military related, but that not all of that military trade is machinery. Our nominal estimate is that 50 to 90 percent of the unreported exports and 40 to 70 percent of the unreported imports each year involve the transfer of military machinery. The remainder are thought to involve military items such as clothing, food, and medical supplies.

Our estimates of net machinery imports must also be converted from current foreign trade prices to current domestic producers' prices (see glossary). Little information is available on the formation of foreign trade prices, so we must estimate the various conversions for most years.

Up to this point, we have calculated the value of all machinery that is available as a finished product to the domestic Soviet econo-

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[3] Vladimir G. Treml, Barry L. Kostinsky, and Dimitri M. Gallik, "1966 Expost Input-Output Tables for the USSR: A Survey," *Studies in Soviet Input-Output Analysis*, ed. V. Treml (New York: Praeger, 1977), pp. 47, 49; Dimitri M. Gallik, Barry L. Kostinsky, and Vladimir G. Treml, *Input-Output Structure of the Soviet Economy*, Bureau of Economic Analysis, April 1983), p. 76; and Dimitri M. Gallik, Meredith Heinemeier, Barry L. Kostinsky, Vladimir G. Treml, and Albina Tretyakova, *Construction of a 1977 Soviet Input-Output Table* (Washington, DC: US Department of Commerce, Bureau of the Census, January 1984), p. 8.

my. The next steps attempt to separate civilian and military machinery deliveries by subtracting the civilian portion from the total. The first two steps deal with the removal of a major category of machinery used in civilian investment and consumption, and the final step involves the deduction of the value of capital repair work on civilian machinery.

Civilian purchases of producer durables

The estimation of the producer durables component of MBMW deliveries to final demand involves several steps. The estimate consists of three parts:

—The machinery and equipment component of new fixed investment.

—Purchases by budget-supported institutions, which consist mostly of schools and government institutions (excluded from new fixed investment statistics since 1964).

—Changes in the stocks of uninstalled equipment at construction sites.

Only the machinery and equipment component of new fixed investment is reported annually. Data for the other two series must be estimated from scattered reports. In addition, the three series are not comparable to the data reported for other machinery uses in terms of the price base and the coverage.

Some defenses expenditures may be included in all three parts of the producer durables series. The military purchases many items, known as common-use durables, that are also used in civilian activities. These items, which would be considered part of investment in the civilian sphere, include trucks, cars, cranes, transport ships and aircraft, and organizational equipment. We cannot easily divide producer durables into the civilian and military parts, but we estimate that military purchases represent 10 to 20 percent of the value of deliveries of producer durables to final demand. Therefore, to leave the military's portion in the residual, we subtract 80 to 90 percent of the estimated producer durables from MBMW deliveries to final demand.

Civilian purchases of consumer durables.

Purchases of consumer durables also must be subtracted from MBMW deliveries to final demand. Consumer durables purchases consist of two parts: private consumption, which includes purchases by individuals for private use, and public consumption, which includes purchases by budget-supported institutions.

We derive an estimate of consumer durables using data from two different sources:

—The Soviets have published information on private and public consumption of machinery products in 1966 and 1972 in connection with their work on input-output tables. Since they do not report the growth of this consumption, we must estimate values after 1972. On the basis of our research on Soviet GNP, we believe that, by the mid-to-late 1970s, growth in the machinery component of consumer durables had fallen to one-half the rate in 1966–72.

—The Soviets also report data on the share of industrial consumer goods originating in the machinebuilding sector each year in the *Narkhoz*.

The results produced from the *Narkhoz* data are consistently about 20 percent higher than those derived from input-output data. We cannot explain the difference, and thus range our annual estimate of consumer durables between the high and low values produced by these two techniques.

The reported data on consumer durables probably reflect both civilian and military purchases, but their separation is not straightforward. We assume that purchases by military institutions are reflected in statistics on public consumption and calculate them by estimating the value of machinery purchased by military scientific institutions for research and development. These are thought to represent the bulk of all military purchases of consumer durables. To remove only civilian purchases of consumer durables from deliveries to final demand, therefore, we subtract total purchases minus the purchases by military scientific institutions.

Capital repair of civilian machinery

The final step in the deduction of civilian purchases of machinery is the estimation and subtraction of the value of capital repair of civilian machinery from total capital repairs.[4] The Soviets do not publish a value for annual expenditures on capital repair—which includes repair of machinery, buildings, and structures—but we are able to construct a series by combining published data on three major categories of capital repair:

—Amortization of the costs of capital repair.

—Budget expenditures on capital repair of buildings and structures.

—Collective farm expenditures on capital repair.

In 1959, 1970, and 1976, machinery repair accounted for 43 percent, 59 percent, and 54 percent, respectively, of the total, according to Soviet sources. The rest was used for the repair of buildings and structures. By interpolating and extrapolating the percent of total repair allocated to machinery, we derive a series for capital repair of machinery alone.

Military repair may be included in the data, and we follow a DIA technique to separate it from civilian repair. This approach assumes that the ratio of capital repair of military machinery to total capital repair is the same as the ratio of military machinery to total machinery.[5] To calculate this percentage, we subtract all capital repair from MBMW deliveries to final demand—leaving only machinery purchases—and from the residual calculated so far, leaving only military machinery purchases. The ratio of these military purchases to total purchases is multiplied by total capital repair outlays to find the military's share of capital repair. This portion of repair is included in the residual and the civilian portion omitted.

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[4] Capital repairs, in contrast to routine maintenance, are major repairs that extend the working life of the machinery, such as the replacement of a truck engine.

[5] Military durables may be maintained better than civilian durables, but they are generally operated less. We assume that the additional annual cost for capital repair caused by better maintenance is offset by the savings resulting from less operation.

Military machinery purchases—the residual

After civilian purchases of machinery and civilian machinery capital repair are removed, the value remaining represents both an estimate of the military purchases included in reported purchases of producer and consumer durables and capital repair and an estimate of residual—or unreported—machinery purchases. Assuming the data have been correctly interpreted and processed, this value for each year represents military purchases of MBMW output of final products, which we refer to as military machinery purchases.

RESULTS

The methodology described above has been used to produce two different residual estimates: one in current prices and one in 1970 comparable prices.[6] Both estimates are calculated for the years 1966 to 1985. Each series includes a range within which we believe the true value of expenditures falls. We also present a "nominal" estimate, calculated from the nominal estimate at each step--in most cases, the mean between the high and low estimates.

Estimate in current prices

The range of values that results from the application of our methodology is very wide. The cumulative value of the estimates from 1966 to 1985 ranges between −30 billion and just over 700 billion rubles in current prices (see figure 2). The nominal estimate is just under 400 billion rubles. According to this estimate annual military purchases from MBMW grew from about 10 billion rubles in 1966 to just over 30 billion rubles in 1985. Military purchases grew by 8–9 percent a year from 1966 through the late 1970s but by an average of only 4 percent thereafter.[7] On average, the estimate increased approximately 7 percent annually from 1966 to 1985. Civilian purchases—producer and consumer durables plus capital repair—also averaged about 7–8 percent annual growth (see figure 3). Each year, civilian purchases were two-three times larger than military purchases, indicating that the military purchased about 25–30 percent of the machinery delivered to final demand.

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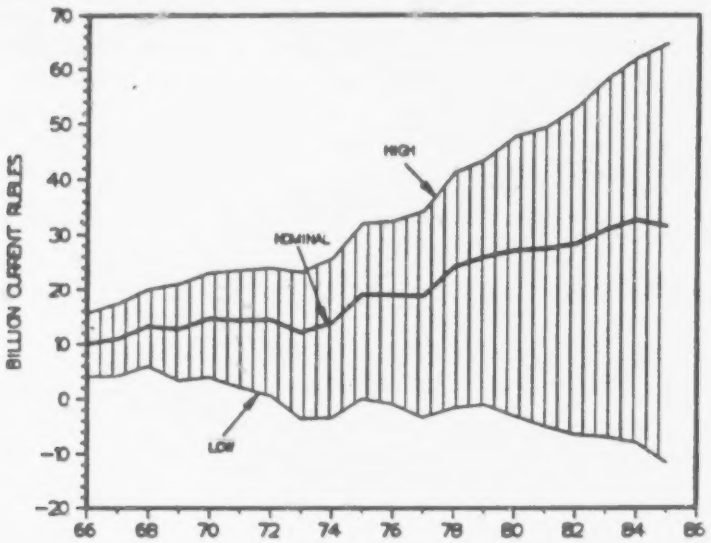
[6] Values in current prices measure actual expenditures. Values in comparable prices are supposed to be in constant or deflated prices. The manner in which comparable prices are calculated, however, results in price and growth indexes that overstate real growth of output and understate inflation. See the section on "Current and Comparable Prices."

[7] We calculate growth rates by determining the annual percentage changes in the data and then taking the arithemetic mean of those changes. The resulting average annual rates of growth are slightly higher than the compound annual growth rate would be. We prefer the annual change method because it takes into account all of the data rather than just the values for the first and last years.

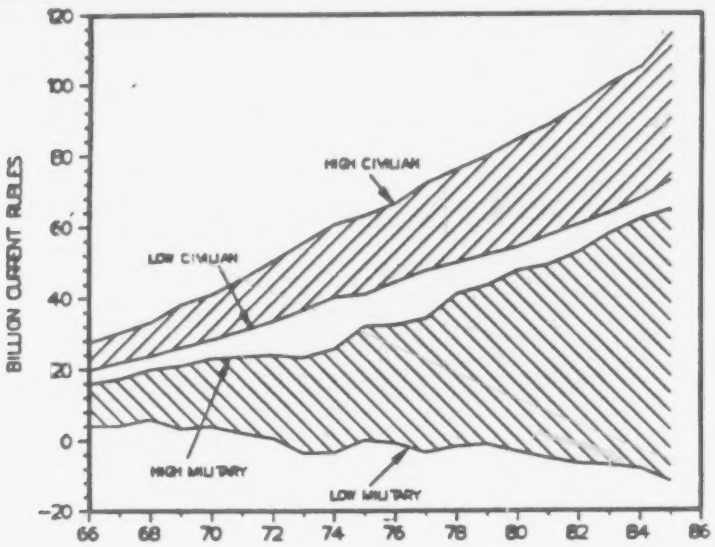
Figure 2
CIA's Residual Estimate of Soviet Military Machinery Purchases, Current Prices



Estimate in comparable prices

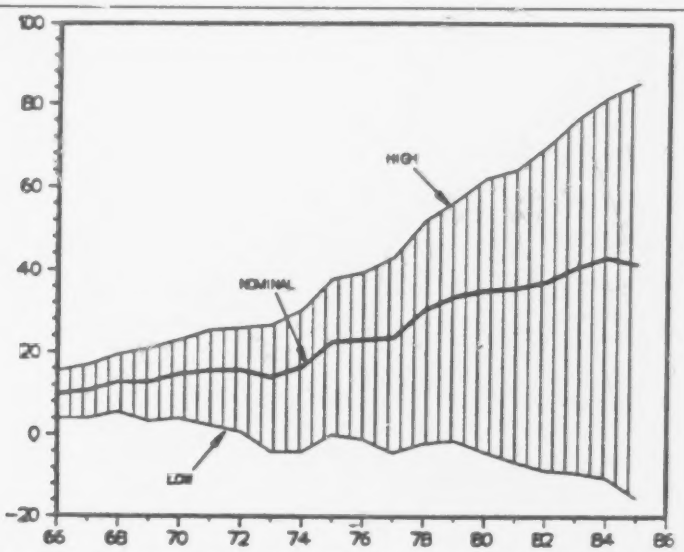
Our estimate of military machinery purchases in 1970 comparable prices is derived by applying the published MBMW wholesale price index to the current-price estimate. The two series are quite similar except for the growth rate. The published price index suggests a decline in machinery prices despite all indications to the contrary (see the section on "Current and Comparable Prices"). Thus, the comparable-price series grows faster than the current-price series.

Figure 3
CIA's Residual Estimates of Soviet Military and Civilian Machinery Purchases, Current Prices



For the 1966–85 period our cumulative estimate in 1970 comparable prices ranges between about −50 billion and almost 900 billion rubles (see figure 4). Our nominal estimate is almost 500 billion rubles. In this series, military machinery purchases were approximately 10 billion rubles in 1966 and climbed to just over 40 billion rubles by 1985. Through 1975, the nominal series grew 10–11 percent per year and, after that, at 6–7 percent annually. Over the entire period, the series increased by an average of 8–9 percent a year.

Figure 4
CIA's Residual Estimate of Soviet Military Machinery Purchases, 1970 Comparable Prices [a]

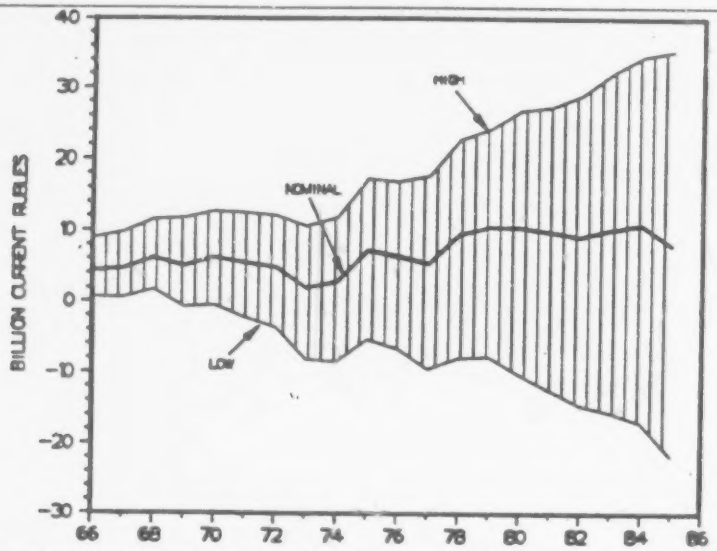


[a] Comparable prices represent the Soviet method of converting industrial output from current prices to constant prices. These prices, however, reflect considerable inflation.

The "Pure" residual estimate

In calculating military machinery purchases as a residual, our low estimate actually fell below zero for several years—an intriguing finding since even the low estimate includes not only residual machinery purchases (any not specifically accounted for), but also a portion of reported "civilian" purchases. We decided to calculate a pure machinery residual, assuming there were no purchases of military machinery in official figures on new fixed investment, public consumption, and capital repair. We found that under this assumption the residual practically disappears (see figure 5). It ranges from zero to 9 billion rubles in 1966 and from −22 billion to 35 billion rubles in 1985. The nominal estimate suggests the residual was less than 8 billion rubles in 1985, not nearly large enough to cover the level of Soviet military hardware purchases estimated by Western analysts.

Figure 5
CIA's Estimate of the Pure Soviet Military Machinery Purchases Residual,[a] Current Rubles



[a] The pure residual is derived by subtracting reported purchases of producer and consumer durables and capital repair from the estimate of machinery deliveries to final demand.

Other Residual Methodologies

As noted earlier, the CIA method owes much to the research of William Lee and DIA. By including more recent information and reflecting uncertainties inherent in the estimative process, however, we have developed detailed calculations that differ significantly from Lee's and DIA's (Table 1 summarizes the differences for 1970). Some of the differences in the coverage claimed for each of the residuals and in the price bases employed are:

—DIA and Lee interpret their residuals as total defense procurement. We interpret ours as military purchases of MBMW output, a less comprehensive concept.

—CIA and DIA include military metalworking and repair—two components of MBMW—in the residual, but Lee does not consider them to be defense procurement and subtracts them.

—Lee calculates a series in 1970 comparable prices and DIA derives a series in current prices. We calculate a series in current prices and convert it to 1970 comparable prices using the published MBMW wholesale price index.

In addition, the three methodologies do not agree on the location of military machinery in MBMW output statistics:

—Lee assumes that reported purchases of machinery (except those for public consumption) are entirely civilian, and the residual military.

—DIA includes both residual machinery purchases and portions of reported purchases of producers durables and capital repair of machinery in its estimate.
—We believe the evidence is not sufficient to determine the location of military purchases in the data. Thus, we calculate both a pure residual and an estimate of military machinery purchases that includes the pure residual and a portion of producer and consumer durables and capital repair. (In the following comparisons we use the latter estimate.)

TABLE 1.—SOVIET MILITARY MACHINERY PURCHASES: COMPARISON OF CIA'S DIA'S, AND LEE'S RESIDUAL METHODOLOGIES AND RESULTS, 1970

	CIA			Lee			DIA		
	Estimate (billion rubles)	Methodology	Problems	Estimate (billion rubles)	Difference from CIA's method	Problems	Estimate (billion rubles)	Difference from CIA's method	Problems
Machine building and metalworking (MBMW) gross value of output.	83.9 to 86.4	Uses reported figures and labor force and amortization methods.	Data on incentive payments and social insurance imcomplete.	94.6	Uses labor force method.	Double counts incentive payments.	86.4	Uses amortization method.	Combines data in comparable and current prices.
Metalworking and repair.				18.7	Deducts all metalworking.	Metalworking could be in procurement.			
Final demand ratio	0.54 to 0.56	1966, 1972, and 1977 data from input-output tables.	Must extrapolate for remaining years.	0.600 to 0.620	Uses 1966 ratio for every year.	Has not used declining ratios for later years.	0.54 to 0.59	Ranges between 1966 and 1972 ratios.	Assumes the ratio does not decline.
Net machinery imports.	−1.0 to 0.5	Includes 50 to 90 percent of export and 40 to 70 percent of import residuals.	Contents of overall trade residuals are uncertain.	0.8 to 2.4	Does not include any of trade residual.	Some of trade residuals may be military goods.	0.0	Assumes 70 percent of overall trade residual is machinery.	Does not express the uncertainty.
Civilian purchases of producer durables.	18.6 to 23.9	Includes investment, budget purchases, and change in stock of uninstalled equipment.	Only investment data published and military share uncertain.	25.3	Assumes all reported purchases are civilian purchases.	Some military purchases may be included.	21.0 to 21.6	Uses only investment data.	Uninstalled equipment and budget purchases are not accounted for.
Civilian purchases of consumer durables.	4.8 to 5.7	Includes all private and civilian public consumption.	Growth rate of consumer durables and military share uncertain.	3.9 to 4.0	Includes only private consumption.	Some civilian purchases are probably in public consumption.	6.6	Includes all private and public consumption.	Some military purchases may be in public consumption.

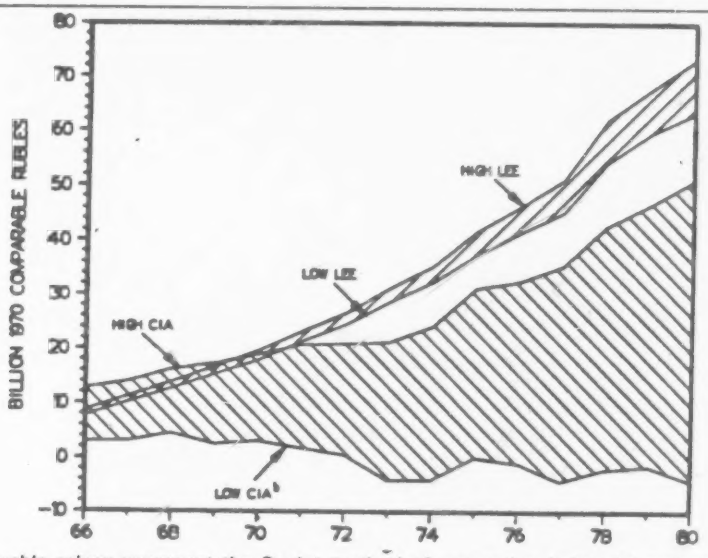
TABLE 1.—SOVIET MILITARY MACHINERY PURCHASES: COMPARISON OF CIA'S DIA'S, AND LEE'S RESIDUAL METHODOLOGIES AND RESULTS, 1970—Continued

	CIA			Lee			DIA		
	Estimate (billion rubles)	Methodology	Problems	Estimate (billion rubles)	Difference from CIA's method	Problems	Estimate (billion rubles)	Difference from CIA's method	Problems
Capital repair of civilian machinery.	5.1 to 10.0	Uses data on amortization, budget, and *kolkhoz* repair expenditures.	Capital repair not annually reported and military share uncertain.		Deducts both military and civilian repair.	Capital repair may be a procurement cost.	5.9 to 6.2	Estimates 30 percent of total capital repair is military.	Share may not be constant over time.
Military machinery purchases (residual).	4.7 to 20.4	Estimates military purchases of MBMW output.	Contents of residual are uncertain.	17.8 to 19.5	Interprets residual as defense procurement.	Contents of residual are uncertain.	12.4 to 17.6	Interprets residual as defense procurement.	Contents of residual are uncertain.

COMPARISON OF LEE'S AND CIA'S ESTIMATES IN COMPARABLE PRICES

Lee's residual series for 1967–80 in 1970 comparable prices grows at an average annual rate of 16 to 17 percent. CIA's comparable-price series, with metalworking and repair excluded for comparability, increases much more slowly over the same period—the low series declines and the high series grows by 10 to 11 percent annually. The levels of the two residual estimates also differ significantly. Although Lee's average estimate of military hardware purchases is almost the same as CIA's for 1966, it is three times higher by 1980.[8] Lee estimates that cumulative spending from 1966 to 1980 was about 500 billion rubles, while the CIA's nominal estimate totals less than 200 billion rubles and the high estimate is about 400 billion rubles (see figure 6).

Figure 6
Comparison of Lee's and CIA's Residual Estimates of Soviet Military Machinery Purchases, 1970 Comparable Rubles [a]



[a] Comparable prices represent the Soviet method of converting industrial output from current prices to constant prices. These prices, however, reflect considerable inflation.

[b] Metalworking and repair were subtracted from the CIA residual to make the coverage comparable to Lee's.

The most notable differences between the two residual series is the uncertainty claimed. From 1966 to 1972 both estimates show fairly narrow confidence bands. For this period, most of the data required for calculating a residual are available. For later years, however, many of the essential parameters had to be estimated. The CIA calculations attempted to convey the uncertainty that is

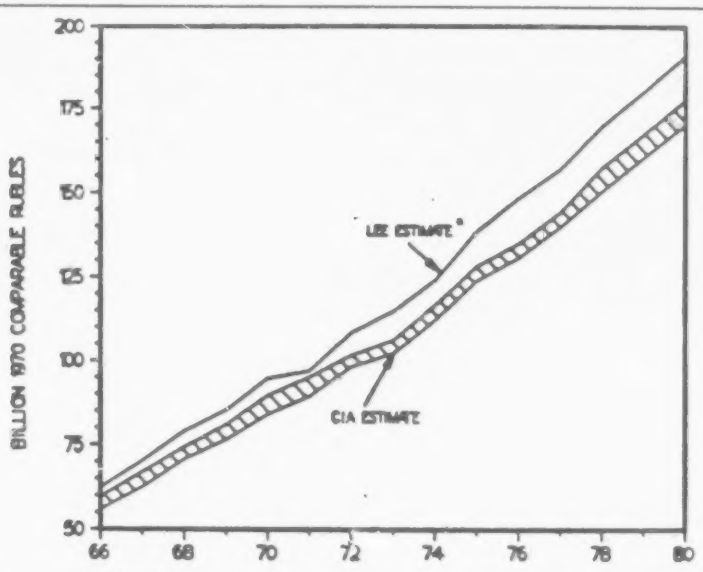
[8] Lee has reported estimates for procurement of 86 billion rubles and 100 billion rubles for 1983 and 1985, respectively, in "Meeting Report" (Washington, DC: The Wilson Center, Kennan Institute for Advanced Russian Studies). 16 October 1985.

inherent in the estimates because trends in the underlying key variables may have changed since 1972. Lee, in contrast, often assumes growth rates (or values) for these variables have remained constant.

The differences between Lee's and CIA's series have many causes. Three principal sources of differences are the estimates used for total MBMW GVO, the proportion of deliveries to final demand in total GVO, and the size of net machinery imports:

—We believe that Lee overstates MBMW GVO. We have identified a source of apparent double counting in his calculations. Because incentive payments to MBMW workers are paid out of profits, they should be subtracted from wages before calculating MBMW production costs. Lee does not subtract these payments, which leads to an overestimation of GVO by approximately 20 billion rubles per year by 1985 (see figure 7).

Figure 7
Lee's and CIA's Estimates and Published Values of Soviet MBMW GVO, Current Rubles



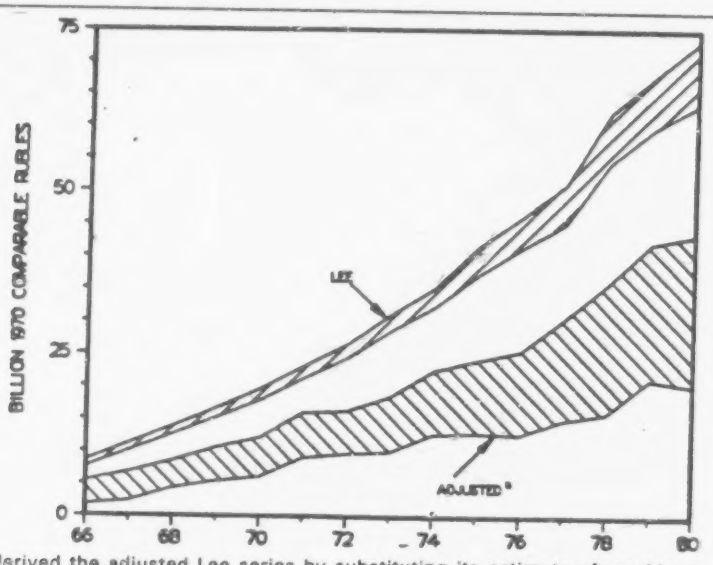
[a] Lee calculates MBMW GVO in 1970 comparable prices. We used his estimating method to calculate a series in current prices.

—We also believe that Lee underestimates the percentage of MBMW GVO accounted for by intermediate products delivered to other producing enterprises. Although the input-output tables indicate a declining trend in the ratio of deliveries to final demand to total gross output, Lee assumes it has remained constant. In addition, he has never updated his estimates and still uses a high ratio from an early 1966 input-output table for every year in his series. As a result, his estimate of deliveries to final demand is too high.

—Finally, Lee uses official Soviet trade data to calculate net imports through 1975 and then extrapolates for the remaining years by assuming that net machinery imports in 1980 were 2 to 2.8 times larger than in 1975. Subsequent to these calculations, however, trade data were published through 1980 that showed net machinery imports—if calculated the way Lee calculated his pre-1976 estimate—were only 7 billion rubles rather than 8–15 billion rubles, as Lee derived by extrapolation.

Substitution of CIA's estimates of machinery available as a finished product to the domestic economy (MBMW final use output plus net machinery imports) in Lee's calculations, leaving all of his remaining assumptions unchanged, significantly alters the level and the range of uncertainty of his residual series (figure 8). Military hardware purchases in the series adjusted by CIA are less than half the size of Lee's annual estimates. In addition, our adjustments double the range of uncertainty surrounding the estimate.

Figure 8
Lee's Residual and Lee's Residual Adjusted by CIA, 1970 Comparable Prices



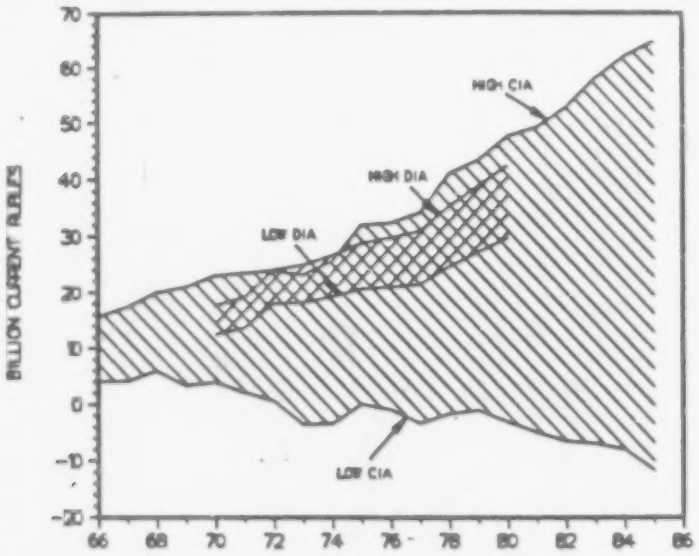
[a] CIA derived the adjusted Lee series by substituting its estimate of machinery available as a finished product to the domestic economy, leaving all of Lee's other calculation unchanged.

COMPARISON OF DIA'S AND CIA'S ESTIMATES IN CURRENT PRICES

The consistency between the levels and trends of DIA's and CIA's current-price estimates of military machinery purchases is greater than that between Lee's and CIA's estimates in comparable prices. Nevertheless, there are still many differences. DIA calculates that, during the 9th and 10th Five-Year Plans (1971–75 and 1976–80), the

Soviets spent between 220 billion and 320 billion current rubles on military hardware (see figure 9). Although the CIA's estimate ranges from less than zero to over 300 billion rubles, its nominal estimate is about 200 billion rubles.

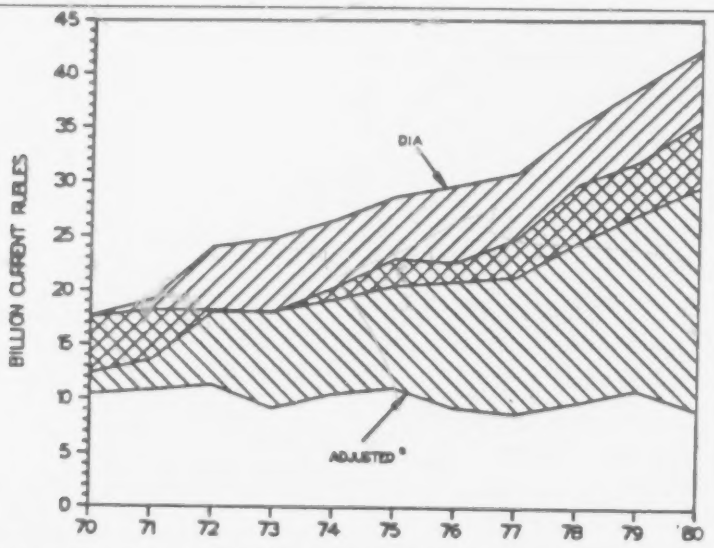
Figure 9
Comparison of DIA's and CIA's Residual Estimates of Soviet Military Machinery Purchases, Current Prices



We estimate that the low current-price residual declined between 1966 and 1985, while the annual growth of the high estimate averaged 11 percent from 1970 to 1980. Growth of the nominal estimate averaged about 7 percent. DIA, in contrast, estimates that military machinery purchases grew steadily at an annual rate of 9 to 10 percent.

Although DIA claims less confidence in the residual than Lee does, it still attaches a range of uncertainty to the estimate that is much narrower than the one CIA calculates. DIA does not substantially widen the range of uncertainty after 1972, even though far fewer of the Soviet building-block data have been published since then. If CIA's estimates of machinery available as a finished product to the domestic economy are substituted for the corresponding values in DIA's calculations, leaving the remaining assumptions unchanged, DIA's series is altered considerably (see figure 10). For 1980, the adjusted estimate is about 15 billion rubles lower than DIA's original estimate, and the average annual rate of growth of the adjusted series ranges from 0 to 8 percent, rather than 9 to 10 percent. DIA's higher growth rate results from its estimates of higher growth rates for MBMW GVO—caused by using data in comparable prices—and its assumption of a higher ratio of deliveries to final demand to total GVO than that used by CIA.

Figure 10
DIA's Residual and DIA's Residual Adjusted by CIA, Current Rubles



[a] CIA derived the adjusted DIA series by substituting its estimates of machinery available as a finished product to the domestic product, leaving all of DIA's other calculations unchanged.

The Uncertainty of Residual Analysis

The magnitude of the differences between Lee's, DIA's, and CIA's residual methodologies and results and the uncertainty of the estimates are not unexpected outcomes of an attempt to uncover state secrets in Soviet economic data. A clear separation of civilian and military production is prevented by:

—Insufficient and conflicting data.
—Incomparable data.
—Uncertainty about data coverage.
—Uncertainty regarding the basic assumptions of residual analysis.

INSUFFICIENT AND CONFLICTING DATA

Even if the problem of identifying civilian and military production in the data could be solved, an accurate residual estimate would still be difficult to obtain because of three main shortcomings in the data:

—Some data are available for only a few years.
—Growth indexes and benchmark estimates of uncertain coverage and reliability must often be used.
—Data provided in different sources are often conflicting.

Filling in the data gaps requires many assumptions.

Incomplete series

Actual data on many of the uses of Soviet machinery output are available for only three benchmark years—1959, 1966, and 1972. Values for the remaining years must be estimated. Most often, the values for 1967–71 are interpolated using the average annual rates of growth calculated from the benchmark figures. After 1972, however, no data points are available to show whether key variables continued to change at the same rate. As a result, the range of uncertainty is extremely wide.

Growth indexes

Relying on growth indexes rather than actual ruble values to calculate a complete time series of machinery output introduces uncertainty. A ruble value for machinery output must be estimated for a base year and then multiplied by the growth index to obtain a time series. Any inaccuracy in the base figure places the entire series for 1966–85 in error in terms of levels and growth rates. In addition, the derivation of the growth index is often unclear, and we cannot always determine if it represents the same coverage as the benchmark estimate.

Conflicting sources

Data required to calculate a residual often can be found in more than one source, each of seemingly equal credibility. When we cannot explain the differences, we range the estimates to include all of the information. In other methods, when the estimates are not similarly ranged, we believe the uncertainty of the calculations is understated. Even so, we cannot always be certain we have captured the true values within our ranges of uncertainty because differences in definitions between various sources may distort the trend and level of our estimates. Thus, even the wide range encompassed by our estimate may understate the underlying uncertainty.

INCOMPARABLE DATA

Soviet economic data frequently are not comparable in terms of the price base and the coverage of the information. Because the information necessary to make the data consistent is not always available, uncertainty is introduced.

We derive residual estimates not only in current and so-called comparable prices, but also on an establishment basis and in producers' prices. The data, however, are not always reported in these prices or definitions. (Table 2 summarizes the various types of data available for residual analysis.) We encounter conflicts between:

—Current and comparable prices.
—Establishment- and commodity-based data.
—Producers', purchasers', "estimate", and foreign trade prices.

Current and comparable prices

In the Soviet Union each product has a comparable price as well as a current price. Just as in open market economies, the current price measures the actual transfer price in any given year. The Soviet concept of comparable prices, however, differs from the

Western concept of constant prices. We believe that comparable prices include "disguised" inflation.

Table 2
Soviet Military Machinery Purchases: Data Available for Residual Analysis

	Comparable or Current Prices	Producers', Purchasers', Estimate, or Foreign Trade Prices	Commodity or Establishment Basis	Data Source
Machine-building and metal-working gross value of output	Current prices	Producers' prices	Establishment basis	*Narkhoz*
Final demand ratio	NA	Producers' prices	Commodity basis	Input-output table
Net machinery imports	Current prices	Foreign trade prices	NA	*Narkhoz*
Machinery producer durables	1969, 1973, and 1984 comparable prices	Estimate and purchasers' prices	Commodity basis	*Narkhoz* and scattered reports
Machinery consumer durables	Current prices	Producers' prices	Commodity and Establishment basis	Input-output table and *Narkhoz*
Machinery capital repair	Current prices	Producers' prices	Establishment basis	*Narkhoz*, state budget, and reports
Military machinery purchases	Goal: current and 1970 comparable prices	Goal: producers' prices	Goal: establishment basis	NA

The primary source of this disguised inflation is the overpricing of new products when they are introduced.[9] In other words, the ratio of the price of the new product to that of the old product is often higher than the differences in the utilities of the two products would support. Overpricing of new products affects the general level of prices used in the derivation of price indexes. The Soviets do not take as the comparable price of new products the price the goods would have received if they had to compete against existing products in the base year in a market in which consumers have free choice. Rather they assign the price at which the good was actually introduced as the comparable price—a price that often reflects high initial unit costs. Thus, an index calculated in so-called comparable prices overstates the growth of real output and understates inflation.[10]

The inadequacy of Soviet price indexes as measures of inflation is most apparent in the MBMW sector. The price index for MBMW is biased more than indexes for other branches of Soviet industry because the product list changes more rapidly in the MBMW sector. Enterprises have powerful incentives to push up the prices of new products, because higher prices allow them to meet planned targets for the value of output and, as a result, more bonuses are available. A manager may justify a higher price for a new product by overstating its technical complexity, by understating the capabilities of goods that would be replaced by the new good, and by overstating the costs necessary to retool the factory to begin pro-

[9] See James Steiner, *Inflation in Soviet Industry and Machine-building and Metalworking (MBMW) 1960–75.* (CIA, Office of Strategic Research, 1978); Fyodor I. Kushnirsky, *Price Inflation in the Soviet Machine-Building and Metalworking Sector* (Philadelphia, Temple University, January 1983); and Fyodor I. Kushnirsky *Estimation of Real Growth and Productivity in the Soviet Machine-Building and Metalworking Sector* (Falls Church, Virginia: January 1986).

[10] As suggested by Kushnirsky in *Price Inflation*, another source of hidden inflation may be the declining quality of goods already in production.

duction of the new good. In addition, raising the prices of new products by more than is justified by the change in quality allows managers to offset the decline in profits that often occurs because the prices of old products are frozen, even though the costs of inputs increase.

The differences between constant, comparable, and current prices have significant implications for defense spending estimates and our understanding of how these estimates change over time. Since there are no precise measures of Soviet inflation, the differences between the three types of prices cannot easily be interpreted. Conversions from current to constant prices require risky assumptions. Our military residual in comparable prices grows faster than our series in current prices, implying a decline in machinery prices. We—and many Soviet authorities—believe prices have actually increased, however, mostly as a result of new product pricing. Lee, in contrast, believes that Soviet comparable prices exclude all inflation. DIA assumes that comparable prices are virtually equivalent to current prices and uses them interchangeably.

Producer's, purchasers', foreign trade, and estimate prices

The Soviets generally report data in either:

—Producers' prices, which are essentially the prices at the factory gate.

—Purchasers' prices, which include transportation and distribution charges, taxes, and customs duties in addition to producers' prices.

—Foreign trade prices, which unlike domestic prices, fluctuate as world market conditions change.

—Estimate prices, which are the supposedly fixed prices used by the Soviets in planning and valuing real investment. These prices include transportation costs.

We chose to calculate a residual in producers' prices because most of the necessary data are reported in these and because they are used by Lee and DIA, facilitating comparisons. Since not all output data are available in producers' prices, we must estimate the conversion coefficients necessary to make them consistent. The information required to derive the coefficients, however, is scarce.

The conversion of purchasers' prices to producers' prices involves the removal and reallocation of taxes and distribution charges. Vladimir Treml, Dimitri Gallik, and Barry Kostinsky have developed methodologies for these conversions in their work on changing the 1966, 1972, and 1977 input-output tables from purchasers' prices to producers' prices. We interpolate and extrapolate from their data to derive coefficients for the whole 1966–85 period.

The conversion of estimate prices to producers' prices is less certain. Estimate prices include additional charges similar to those in purchasers' prices. For lack of a better estimate, most residual approaches, including the CIA's, simply apply a coefficient similar to that used to convert purchasers' prices to producers' prices.

Coefficients to convert foreign prices to domestic prices were also estimated for the input-output tables. The coefficients were determined by comparing machinery prices reported in both foreign trade prices and domestic prices. Because the calculation is complex and a limited sample of machinery is available for analysis,

the coefficients were estimated for most years and are quite uncertain.

Establishment and commodity basis

MBMW GVO calculated from data reported in the *Narkhoz* represents the sum of the ruble values of output of all enterprises that primarily produce machinery and metal articles or repair machinery. Output reported in this manner—that is, on an establishment basis—does not include machinery produced as a secondary product in nonmachinery enterprises of the economy. Furthermore, it includes the nonmachinery output of MBMW enterprises.

Commodity-based data used in input-output analysis, on the other hand, classify items into similar product groups. Machinery produced outside of MBMW industries is reported with the machinery output of MBMW enterprises, and the nonmachinery output of MBMW enterprises is not included therein. Commodity-based data are preferred for residual analysis because they capture all MBMW output, regardless of where it is produced. Because commodity-based machinery output data are only available for the years of the input-output tables, a complete military residual series cannot easily be calculated. Therefore, we derive an establishment-based residual.

The uncertainty in a commodity-establishment conversion is readily apparent. Originally, we had only one coefficient (0.92), reported by the Soviets for the year 1959, to convert from a commodity to an establishment basis. In the absence of additional data, this coefficient was used by the input-output experts to estimate commodity-based MBMW GVO for an early version of the 1966 input-out table. After publication of this table, actual commodity-based data were obtained and the input-output table was updated.[11] As a result of the update, the 1966 value for MBMW GVO on a commodity basis changed from 54.7 billion to 61.1 billion rubles and the commodity-establishment conversion coefficient changed from 0.92 to a range of 1.06 to 1.09. We have since calculated a coefficient of 1.08 to 1.09 for 1972 by comparing our establishment-based MBMW GVO with the commodity-based MBMW GVO published in the 1972 input-output table.

Some commodity-based data—benchmark estimates of the ratio of MBMW deliveries to final demand to MBMW GVO and estimates for consumer durables—must still be used. We assume that a ratio of final deliveries to GVO on a commodity basis would not differ from one on an establishment basis, and we do not adjust the ratio. We do, however, adjust the consumer durables data to an establishment basis by applying a conversion coefficient of 1.05 to 1.10. This ratio applies to MBMW as a whole (with a range of uncertainty attached), and we do not know whether it applies to the various components of MBMW.

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[11] Vladimir G. Treml, Dimitri M. Gallik, Barry L. Kostinsky, and Kurt W. Kruger, *The Structure of the Soviet Economy* (New York: Praeger, pp. 123–45, 171–81, and Treml, Kostinsky, and Gallik, "1966," pp. 47–49.

UNCERTAINTY ABOUT DATA COVERAGE

A major shortcoming of the machinery residual approach is the inherent uncertainty about the coverage of the final estimate. Some residual analysts consider the residual to include all defense procurement. We believe, however, that even if the data could be correctly processed, procurement items not produced in the MBMW industries would be excluded from the residual. In addition, because the data are on an establishment basis, they most likely include nonmachinery items that would not be considered procurement. Thus, we believe that a residual cannot be interpreted strictly as defense procurement.

Although it is difficult to isolate the nonmachinery production of MBMW industries, we can identify possible sources of military procurement not included in MBMW. One source might be the fuel or chemical industries, which produce missile propellants and munitions. Two large possible sources might be the production of "other branches of industry" and the portion of the production total for manufacturing industries that is not specifically accounted for. As reported in *Vestnik statistiki*, no. 2, 1986, the GVOs for these two components were 20 billion rubles and 82.6 billion rubles, respectively, in 1984.

UNCERTAINTY REGARDING THE BASIC ASSUMPTIONS OF RESIDUAL ANALYSIS

Two assumptions are central to the various machinery residual methodologies—that reported data on the total output of MBMW include production for both the military and civilian sectors and that data on the purchases of MBMW output for investment, consumption, and repair represent only civilian purchases. The validity of these assumptions cannot be demonstrated, however. In fact, to produce a reasonable estimate of military purchases of machinery, we must assume that some of the reported purchases are military. If we calculate a "pure" residual by assuming that all reported purchases for investment and consumption are for civilian purchases, virtually no residual remains. This suggests two possibilities:

—All or some military production may be excluded from the data on MBMW GVO.

—Some or all military purchases of machinery may be included in MBMW GVO but are not hidden in the data as a residual. Rather, they are distributed throughout the reported data on purchases of MBMW output.

Military purchases excluded from the MBMW output data

Beyond our discovery that the above assumptions do not allow calculation of a reasonable military machinery residual, we do not have sufficient evidence to conclude that military production is intentionally excluded from Soviet production data. A Soviet emigre, Dmitri Steinberg, has prepared a [draft] report on Soviet economic balance tables in which he asserts that, contrary to the established view, military production is excluded from data on Soviet produc-

tion of machinery delivered to final demand.[12] His conclusion is not clearly supported, but it suggests that we may not be able to assume that all defense production is included in the MBMW data.

If this assertion is true, the implications are important:

—Residual analysis cannot be used to estimate military hardware purchases.

—MBMW GVO—including both civilian and military machinery—is higher by an unknown amount than the reported figures.

Military purchases included in reported purchases

Instead of being totally excluded, some military purchases may be included in the reported Soviet data on purchases of MBMW output—that is, the items usually assumed to be for civilian use and thus subtracted to find the residual. Civilian and military industrial production within the Soviet Union are closely linked. Industries assigned to civilian production are structured to support and augment those assigned to the military, especially during periods of mobilization. For example, factories manufacturing farm tractors have produced military personnel carriers, and civilian machine-building plants have constructed missile launchers.

To obtain our estimate of military purchases of machinery, we assume that some military-related purchases are included in the reported data on ostensibly civilian purchases of MBMW output. In the estimation of producer and consumer durables and capital repair of civilian machinery, therefore, we deduct an estimate of military purchases at each step, as described in the earlier section "Building an Estimate." (Hence they remain in the overall estimate of military purchases—the residual.) Unfortunately, since published Soviet statistics do not contain any information to help us determine the size of these military purchases, residual analysis will not by itself provide accurate estimates of military machinery purchases—the task becomes one of separating civilian and military purchases as well.

Evaluation of Machinery Purchases Residual

In the abstract—as noted in the first section of this paper—the residual approach to estimating purchases of military hardware seems attractive. It relies on information that is openly published, it attempts to reflect the Soviet view of accounting for military and civilian expenditures, and it requires little in terms of time and money for research. In short, minimal effort is required to produce a major estimate. But any procedure used in measuring Soviet defense spending must be judged by the reliability of the estimates it produces.

Because of the many uncertainties inherent in the procedure, we believe residual analysis is unreliable as an independent method for estimating Soviet purchases of military hardware. Soviet economic statistics do not allow a clear indentification of either military or civilian machinery purchases. We cannot determine wheth-

[12] Dmitri Steinberg, *USSR National Economic Balance Tables: Estimating Soviet Military Expenditures for 1965, 1970–82* (Washington, DC: Department of Defense, Office of Net Assessment, working paper, March 1986).

er military purchases are included in reported purchases for investment, consumption, or other purposes or whether some or all are excluded altogether. Therefore, we do not know whether they are all contained in a residual estimate. Furthermore, we cannot determine what adjustments would be necessary to convert an estimate of military machinery purchases to an estimate of Soviet defense procurement.

Estimates of military machinery purchases themselves are distorted because of hidden inflation in the MBMW sector. Soviet price indexes calculated in comparable prices understate inflation, leading to an overstatement of growth of real output. As a result, we are unable to separate real from inflationary growth in the Soviet MBMW sector using published statistics.

Finally, as the comparisons of our residual estimates with those of Lee and DIA illustrate, the tremendous range in both the levels and growth rates of the estimates severely limits their usefulness. The conflicting results illustrate a problem inherent in the approach—that differences in the assumptions embodied in residual analysis can cause considerable variation in the estimates. Moreover, very little of the economic data necessary to estimate reported purchases of machinery—setting aside the question of whether they include the military purchases—have been available since 1972. To obtain figures for recent years, analysts must estimate values of deliveries to final demand, net machinery imports, purchases of consumer durables, price changes, and the relationship of commodity basis to establishment basis. If early benchmark estimates of these values are inaccurate, then extrapolating and using growth indexes and planned growth rates introduce considerable error into the estimates for later years. Without new data points, and especially more information on the location of military machinery purchases in Soviet statistics, residual analysis will become increasingly less reliable.

Glossary

MBMW GVO.—Gross value of output (GVO) of the machine-building and metalworking (MBMW) industries in the Soviet Union. It includes the value of finished MBMW output ready for sale, output that will be used further in the production of other items, and repair work.

MBMW Intermediate Products.—Machinery output sold to other producing enterprises for further processing or to be used in current repair.

MBMW Deliveries to Final Demand.—MBMW GVO minus MBMW intermediate products. It represents all machinery available for sale to final end uses—consumption, investment, defense, and foreign trade.

Net Machinery Imports.—Total machinery imports minus total machinery exports.

Producer Durables.—The machinery and equipment component of investment that is purchased by production enterprises, purchases by budget-supported institutions, and changes in the stocks of uninstalled equipment at construction sites.

Consumer Durables.—The machinery purchased by individuals for private use or by public institutions serving the population.

Capital Repair.—Repair work on machinery that increases its asset value and is therefore counted in the investment part of Soviet national income.

Military Machinery Purchases Residual.—Purchases of military machinery estimated by subtracting identifiable nondefense purchases from MBMW deliveries to final demand in the Soviet economy.

Defense Procurement.—Annual cost of procuring new weapons and equipment and their initial spare parts for the military.

Current Prices.—Prices attached to machinery output in a given year.

Comparable Prices.—Prices which represent the Soviet method of converting industrial output from current prices to constant prices. These prices, however, include considerable inflation.

Producers' Prices.—Prices charged by the enterprise at the factory gate.

Purchasers' Prices.—Producers' prices plus transportation and distribution charges, taxes, and customs duties.

Foreign Trade Prices.—Prices at which Soviet goods are bought and sold in foreign trade. They are set by Soviet planners in a process separate from the establishment of domestic prices and fluctuate as world market conditions change.

Estimate Prices.—Fixed prices used by the Soviets in planning investment.

Establishment-Based Data.—Output data that represent the sum of the ruble values of output of all enterprises that produce machinery and metal articles primarily or repair machinery. Output reported in this manner does not include machinery produced as a secondary product in non-MBMW enterprises.

Commodity-Based Data.—Output data that represent the sum of the ruble values of output of machinery, regardless of where it is produced. Machinery produced outside of MBMW industries is included and nonmachinery output of MBMW enterprises is not included.

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SOVIET MILITARY HEALTH ISSUES

By Murray Feshbach*

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SUMMARY

Perhaps in respect of *glasnost', Izvestiya* published an article in late 1986 (11 December to be exact) containing a list of serious medical problems among potential conscripts for the Soviet armed forces. Many of these illnesses gave rise to their rejection for service.[1]

According to *Izvestiya,* the number of males rejected for medical cause in the Soviet Union "has not decreased." This situation is not unprecedented in East Europe. The poor quality of military recruits is openly discussed in Hungary. According to a speech to the National Assembly by the Hungarian Defence Minister, Colonel General Ferenc Karpati on 26 June 1986, some 10 to 11 percent of young Hungarians are "unfit for military service," and 4 to 5 percent more are only moderately fit for service and had to be excused from hard physical training.[2] Why have medical rejections for service increased in the USSR? Leaving out the cases of bad eyesight cited in *Izvestiya,* serious illnesses such as liver (read: alcohol-related?) and kidney disease, as well as ulcers and nervous disorders are cited as principle causes for rejection. As will be documented from Soviet sources below, there are many other serious illnesses affecting potential conscriptees and active duty personnel. In addition, *Izvestiya's* correspondent notes, psychiatric and narcological specialists have now been assigned to each medical commission of con-

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[1] Footnotes at end of article.

scription boards throughout the country. The former may well be in compliance with the call of a number of articles in the Soviet military medical sources for the assignment of such specialists given the apparent prevalence of "borderline psychiatric illnesses" cited since 1983.[3] Regarding the need for "narcological" specialists, perhaps drug abuse among the population is much larger than hitherto believed, in addition to the now well-established problem of alcohol abuse. Medical problems exist everywhere, with Uzbekistan as well as the Baikal and Ural regions as well as Siberia being cited as particularly bad.

These recruits undoubtedly reflect the general health status and illness pattern of young people throughout the country, if not the entire population. Evidence abounds of serious health delivery problems by the health agencies as well as individual physicians and other medical personnel.[4] In a television interview on 15 June 1986, Dr Sergey Burenkov, the USSR Minister of Health, spoke of the need to "largely reorganize the teaching process" of medical personnel, to include "questions of medical deontology-humaneness, medical ethics, and, I would say, compassion". Further, in a Moscow Radio home service broadcast earlier in the same day, Burenkov underscored the ethical side of the health delivery issue, by admitting that "I must say that there are many complaints from the public about negligent and indifferent attitudes toward patients. Unfortunately, there are still cases of importunate solicitation and—even worse—of bribery".[5] *Sovetskaya Rossiya* noted in 1984 that "callousness, hardheartedness, and even criminal negligence committed by personnel at medical institutions have led to grave consequences and have cast a dark shadow over representatives of this humane and noble profession". And, further, that "the number of complaints about activities incompatible with medical ethics has not been decreasing in recent years".[6] Party leaders at Central Committee Plenums, or senior analysts such as Yu.P. Lisitsyn of the Ministry of Health at meetings of the Academy of Medical Sciences, or A.G. Aganbegyan, the economic adviser to Gorbachev, have noted the need for significant, serious qualitative improvement in the health area.[7]

In addition, there is much reporting of overcrowding of medical facilities. The article by Boris Mozhayev, in *Literaturnaya gazeta* of 19 September 1984, is the most widely cited description of the problem. Not only hospital corridors in the Moscow and Tallinn medical facilities to which he went for treatment were filled with patients in beds and with doctors giving treatment and consultations, but in Tallinn, they also used staircase landings as well as the small space outside the washrooms. Even in the largest hospital of the country, the First Moscow City Hospital (the well-known Botkin Hospital), had patients reportedly dying unattended in corridors.[8] Although the numbers of doctors as well as hospital beds are much larger in absolute and per capita measure in the USSR than in other countries, the health delivery problem is compounded by the shortfall in supplies of modern antibiotics and medicine for individuals suffering from cardiac diseases, as well as simple aspirin, which continue despite large increases in imports from the West as well as East Europe. Sources published in the general press during 1986 alone, indicate the shortage of half of the needed

antibiotics, chronic unavailability of medicine for cardiac patients, more equipment supplied but of the minor type and the supply of the "dozens and even thousands of high-grade instruments . . . still being produced in small quantities", unreliability of blood pressure devices, and the shortfall of overall supply of medications even though high-level medical authorities asserted that supply is approaching 100 percent of demand.[9]

Lack of supplies is one facet of the problem, another is economizing to a degree that may perhaps contribute to the overall problem. Thus, military medical service personnel are enjoined to make--

> a significant savings in bandages [which] can be achieved through their sensible use, their reuse after laundering, replacing . . . sterile materials with non-sterile, bandages with adhesives, and so forth.[10]

As a result of these basic problems, the deliverers of medical services of necessity cope with fundamental issues which may have overwhelmed them until the recent period when more attention and some more resources are being applied.

Overall Trends in Mortality and Morbidity

From the trends in crude death rates, we see an increase in these rates after a post-Second World War decline of much note. Thus, the crude death rate (the absolute number of deaths per 1,000 population increased by over 49 percent between 1964 and 1980, a very slight decline for 2 years, then another jump from 10.1 to 10.4 in 1983 and 10.8 in 1984; the latter being a post-war high some 57 percent more than in 1964, the officially reported low crude death rate of 6.9 deaths per 1,000 population. In 1985, a slight decline occurred (at 10.6) but to a level still 54 percent higher than two decades earlier. In all, much higher than one could expect from changes in the age structure of the population alone.

The spread of infectious disease, to be discussed below, is not limited to illness only, but may have led to remarkable increases in mortality if the evidence from Tadzhikistan is applicable also to the remainder of Central Asia and potentially growing within the military as the share of the conscript cohorts coming from this region increases in the future. Thus, according to direct evidence published in *Zdravookhraneniye Tadzhikistana*, the journal of the republic's Ministry of Health, "Infectious and Parasitic Diseases" as a cause of all deaths increased from 19.5 percent in 1970 to 26.1 percent in 1980 among 0 to 3 year olds.[11] Other articles in this journal indicate that for the republic's population as a whole, "infectious and parasitic diseases" as a cause of death more than tripled in the short space of 6 years, increasing from 5.9 percent in 1975 to over 18 percent in 1981.[12]

Mortality at the prime working and military ages also must have increased markedly when one considers two reports about increases in mortality during the period 1965 to 1982 in "a number of large cities" in the RSFSR of males surviving to age 60 and of the age-specific death rate for males 35 to 39 years of age in Belorussia in the 1970s. Thus, for the former grouping, the results of a survey conducted in large cities (presumably the better supplied with medical staff and facilities) the number of males age 16 surviving to age 60 amounted to 72,178 per 100,000 in 1965 (only 1 year subse-

quent to the lowest reported crude death rate for a single year) and only 67,791 surviving in 1982. A drop of 6.1 percent in the number of survivors![13] Equally astonishing in dimension and direction of mortality increases is the report for Belorussia—always cited as the union republic with the best health indicators—the age-specific death rate for both sexes aged 35 to 39 increased by 34.6 percent between 1969/70 and 1978/79, whereas for the approximately same period, 1970 to 1978, the United States, the age-specific death rate decreased by 24.5 percent.[14]

In much of the discussion preceding the anti-alcoholism law of June 1985, and in the subsequent period of *glasnost'* about the issue, premature mortality due to alcohol abuse was prominent among these discussions. Boris Yel'tsin, the party leader of Moscow City, is reported in *Le Monde*[15] to have told a gathering of some 6,000 party propagandists and agitators on 11 April 1986 that the life expectancy of all persons living in Moscow had declined in ONLY 2 years, from 70 years of life at birth on the average in 1983 to 68 in 1985. A drop of 2 years in 2 years may be unprecedented in peacetime. It is therefore no surprise that Ligachev, in a speech at Voronezh in July 1986, and other party leaders, have highlighted the drop in alcohol consumption and in heart and circulatory-related deaths in the 12-month period following the implementation of the anti-alcohol drive in the middle of 1985.[16] If true, this has been a major achievement, even if much remains to be accomplished in the health area.

Another approach to the health status of the Soviet population is through the mirror of the trends and levels of illness, or morbidity, with appropriate consideration for differentiation among the age categories, especially the younger groups. A brief examination of the dynamics of these rates demonstrates that the situation is far from satisfactory to the Soviet regime, and the military in particular.

On 15 January 1986, buried within the brief description of the activities of the Central Committee, *Pravda* announced the issuance of a resolution on improving the health of the Soviet work force. Included in the instructions to the head of all economic organizations and institutions was the call to observe norms for industrial sanitation, improvement of preventive health care, and of the medical services.[17] While not specifically related to the military, it would certainly have included the military industrial enterprises and institutions.

Almost exactly two years earlier, *Krasnaya zvezda,* the newspaper of the Ministry of Defence and the Armed Forces, published a notice on its front page about the creation in every military unit, ship and formation of an "Extraordinary Anti-Epidemic Commission" (*Chrezvychaynaya antiepidemicheskaya kommissiya).*[18] Even the designation chosen for the commissions is demonstrative of serious concerns perceived by the leadership. The Russian words for "Extraordinary Commission" are the roots of the Cheka, the predecessor organization of the KGB, let alone the use of the words "anti-epidemic," not just illness itself. What lay behind such manifestations of concern?

One side of the picture can be seen from the numbers of major infectious diseases for the country as a whole. Subsequently the

military dimension of the overall health issue will be discussed in detail. Moreover, lest it be thought that many of these illnesses are limited to young children, *Literaturnaya gazeta* of 21 August 1985 (p. 13), contained an article which cites a Leningrad physician whose monograph clearly noted that the phenomenon was nationwide as well as having more serious consequences for adults. Military physicians also have observed the same pattern growing in the 1970s among soldiers. Improved vaccines are cited by the *Lit. gaz.* article as a necessary preventative. Data from the military medical journals, as will be shown later, on the efficacy of various vaccines show them to be particularly low in avoiding the illnesses they are supposed to prevent.[19]

But it is the living that need to be addressed at this point. Thus, the national figures for diphtheria, typhoid and measles should suffice to give the overall dimensions of the morbidity problem so worrying the Central Committee.[20] Whereas in 1979, the number of cases of diphtheria reported by physicians was officially announced as (a low in Soviet medical history) 200 cases, since then the number has increased dramatically to 1,410 in 1983, 1,610 in 1984, and 1,510 in 1985.[21] Typhoid, which ranges between 100 and 300 cases in the United States as a whole, in recent years, increased in the USSR from less than 16,000 in 1979 to almost 19,000 in 1984 and then declined to 17,600 in 1985. And lastly, measles increased dramatically in the United States in 1986 to 5,850 by the end of October 1986 (primarily due to a drop in vaccination), from a previous 5-year median of about 2,300.[22] In the USSR, the numbers of measles cases increased from a low about 200,000 in 1979 to 466,000 in 1983, a sharp decline in 1984 to 252,500 but an almost 10 percent increase again in 1985 to 272,800. It is not that increases do not occur everywhere due to cyclical patterns or to lack of vaccination among young people in the United States and elsewhere, but why is the level so high in the Soviet Union given the wide availability of vaccines for many years?

Brezhnev's speech at the 26th Party Congress in 1981 gave a hint at the dimension of the medical problem when his Accountability Report to the audience incorporated unprecedently strong remarks about the difficult situation in the health field. Instead of limiting the presentation to a review of the numbers of doctors and hospital beds—as always more, but not necessarily better or properly utilized as it turns out—but also to noteworthy negative comments about the supply of medical cadres, about obsolescent or shortage of medical equipment and medications, about medical ethics, and so forth.[23]

Military Medical Issues

About the time of Brezhnev's speech to the Party Congress, the *Military Medical Journal* (*Voyenno-meditskinskiy zhurnal—VMZh*) contained an article reviewing medical issues in the past five-year plan and the hopes for the new 11th plan period commencing in 1981. Academician, Professor, and Colonel General F.I. Komarov, the head of the Military Medical Service, hinted at the persistence of deep medical problems. Thus, the 1976–1980 period was noteworthy for the "important significance of the anti-epidemic work car-

ried out".[24] Acute respiratory diseases apparently were the major concern of the time. He did not devote any attention, however, to the concern expressed by two other members of his medical service only 6 months earlier in the same journal. According to them, medical defensive measures were needed to avoid the "penetration of especially dangerous infections from less-developed (*neblagopoluchnykh*) countries . . . to [the USSR] and to liquidate the occurrence of outbreaks [of such illnesses]".[25] Nonetheless, 4 years elapsed before the formation of a formal structure to undertake "anti-epidemic" measures; was this perhaps a sign that the warning in 1980 was all too correct as the illness pattern became even more complicated as a different kind of cost of involvement in Angola, Cuba, Vietnam, Ethiopia, and Afghanistan added to their medical burdens? To their credit, about 1 year later, the leading military epidemiologist, Major General V.D. Belyakov, also argued in October 1981 for the creation of special groups who would provide for effective anti-epidemic services to the troops.[26] Two months later, at a meeting convened for the medical service command, the head of the Rear Services of the Soviet Armed Forces, Marshal Kurkotkin stipulated that urgent measures be taken to improve procedures for preventing the spread of infectious diseases.[27] *Krasnaya zvezda,* in the same month underscored the need for serious improvement in an editorial entitled "Concern for the Fighting Man's Health".[28] This editorial explicitly cited the Central Asian, Siberian and Odessa Military Districts, as well as the Northern fleet for not devoting appropriate attention to the "development and improvement of the medical service's material and technical facilities, to the distribution of medical stations and hospitals, and the creation of conditions essential to the examination and treatment of patients. All of these shortcomings must be resolutely corrected".[29] As later evidence will show, these remonstrations were insufficient.

Apparently at about the same time as Brezhnev's speech to the Party Congress, the Ministry of Defense organized a joint military and civilian conference to discuss problems of viral hepatitis in the armed forces. Very likely, many of these issues within the military, and as indicated earlier by the mortality and morbidity statistics, also among the population as a whole, the national authorities felt it necessary to issue a major decree on health in August of 1982. It was the first health decree since 1977, containing virtually the identical words about problems as well as the means for their rectification.

Citing this decree (issued by the Central Committee of the CPSU and the Council of Ministers of the USSR, "On Additional Measures for the Improvement of Guarding the Health of the Population"), Komarov, the head of the medical service, and Major General Agafonov (the co-author of the 1980 article cited earlier), at the Thirtieth Enlarged Plenary Session of the Scientific Medical Council of the Armed Forces held in Leningrad in December of 1982, referred to the necessity for improvements in sanitation, hygiene and anti-epidemic work.[30] Then General of the Army Kurkotkin added comments about positive aspects of medical services, on one hand, and on the other, repeated some of the statements made by the other speakers in asserting the need for improvement in the quality of medical personnel, quality of medical examinations and diag-

noses, food preparation monitoring for the proper handling and inadequacies in medical supplies.[31] At this conference and elsewhere, hygienic conditions apparently play a large part in the underlying causes of medical problems. Resources as well as changes in attitude and training, and not just words in abundance, seem to be needed to rectify the current difficulty. In February 1983, full Admiral Sorokin, First Deputy Chief of the Main Political Administration of the Soviet Armed Forces, in the lead article of the journal of the ideologists, *Voprosy filosofii* (Questions of Philosophy), provided a very unusual three-paragraph statement on demographic problems in the Soviet Union, including their impact on the Soviet military. Among the issues he brought up were the numbers and origins of draftees as well as the lack of any increases in life expectancy. Particular attention needed to be devoted to the "unsatisfactory demographic situation", he asserted, "in order to overcome the negative impact [of these demographic factors] on the combat capability of the Soviet Armed Forces".[32]

One year later came the public announcement of the formation of the Extraordinary Anti-Epidemic Commissions in all military units, as noted earlier.

In May of the same year, 1984, a full and frank criticism of health conditions and their potential damaging impact was made explicit by Major General V. Chevyrev. As Chief Hygienist of the USSR Ministry of Defense it is not surprising that he would address issues of sanitation and hygiene, but the linkage by Chevyrev of what appears to be mundane issues to serious medical problems underscores the type of problem apparently endemic throughout the Soviet armed forces. To quote:

> Particular importance is now attached to the prevention of mass epidemic diseases, such as typhoid fever and typhus, paratyphoid, viral hepatitis, dysentery and other diarrhea diseases (acute intestinal infections) which have the greatest effect upon the combat efficiency of personnel. The level of these diseases depends greatly upon the sanitary-epidemic well-being of the troops.[33]

And to underline the specific problem areas:

> . . . Analysis of the cause for the spread of acute intestinal infections at the troop level showed that up to 70 percent of the illness is associated with the use of poor quality water or its unreliable decontamination.[34]
>
> . . . In a number of places, there are still individual shortcomings in the organization of food preparation which can be a forerunner for the spread of acute intestinal infection and food poisoning. The basic shortcomings here are the low sanitary state of [food] production areas, poor dishwashing, non-adherence to personal hygiene rules by the cooks and their violation of the rules on the sanitary processing, preparation, and storage of food . . . bacteria carriers and even sick individuals are permitted to work with food products. Penetration of a source of infection into the mess hall represents a great epidemic danger which, at times . . . is difficult to prevent with all subsequent sanitary measures.[35]

Obvious, perhaps, but apparently of major concern to the Major General. And even further, and less expected:

> It is also difficult to overestimate the role of bath and laundry service in the life of the troops. As shown by the experience of the Great Patriotic War, it is a most important anti-epidemic measure in the prevention of pediculosis and typhus and relapsing fever which are carried by lice.[36]

If the above did not cause enough sickness, Chevyrev also is worried that:

Dirty clothing infested with microbes also can facilitate the spread of such diseases as typhoid and paratyphoid, cholera, viral hepatitis, dysentery, and diarrhea illnesses.[37]

The materials on the distribution of illnesses in the armed forces demonstrate that General Chevyrev is not exaggerating.

Illness Patterns in the Armed Forces

Illness appears to strike new soldiers particularly badly in the first months of active duty. According to the *Military Medical Journal* of September 1982, ". . . one can observe a lowering of the barriers against disease outbreaks [during] the first months after being drafted . . . in the first three months following induction . . . it is recorded that 68 percent of soldiers have become ill".[38] According to this source, only 8 percent of the soldiers had lived in conditions similar to that being experienced after induction. However, "socio-economic factors" in civilian life and the quality of medical care is clearly listed as a source of possible health problems of armed forces personnel, implying that the 8 percent figure cited in September 1982 may be more directly related to housing conditions than general quality of life measurements.[39]

INFECTIOUS DISEASES

The data published in the annual statistical yearbooks relates to infectious diseases, as noted above. In addition, it is possible to locate in secondary sources direct data or indirect information which allows for the derivation of estimates for infectious and other illnesses. Regardless of the level or rate, infectious diseases are of major concern to the military health authorities in their effort to prevent spread of infections and to keep their personnel fully available for active duty. However, the evidence seems to be descriptive of serious problems in individual types of diseases, their diagnosis, treatment and recovery patterns. Prompt and correct diagnosis would contribute much to the prevention of widespread illness. However, either the medical staff is incompetent (as now being discussed by senior Soviet military authorities), their equipment is inadequate for testing, or the evidence in the military medical sources are completely misleading as to the depth of the problem. A review of the individual diseases afflicting personnel, as well as a brief review of comments on the competence of Soviet military physicians, however, demonstrate that the problem is very serious indeed.

Intestinal diseases

As recently as June 1984 it was noted that intestinal infectious diseases need to be further reduced and that epidemic-type of outbreaks among the troops need to be prevented.[40] How much these illnesses need to be reduced may not be precisely determinable, however, given that only 40 percent, or less than half are correctly diagnosed.[41] The success rate in treatment of former typhoid patients, as reported in June 1984, also seems to be relatively low. Thus, 25 percent of such patients (and 7–9 percent of paratyphoid patients) are still infected after treatment, being classified as bacteria carriers.[42]

Hepatitis

Shortly after the appearance of a major article in October 1983 describing significant increases in the spread of hepatitis among troops stationed throughout the country, the editorial article cited earlier from June 1984 noted the priority need for development of an appropriate vaccine to deal with viral hepatitis A.[43] The evidence from the October 1983 source, and independent estimates for the rise of hepatitis throughout the country (civilian as well as military) underscores the urgency of the issue for the Soviet military. Thus, for the country as a whole, the last reported figure for all types of hepatitis (A, B, non-A and non-B, and unspecified) was 702,000 in 1975; it can be estimated that this number is at the 1,400,000 level in 1982 or 1983.[44] In the October 1983 issue of the *Military Medical Journal*, as noted earlier, information on dramatic increases in hepatitis A was published. Differentials in hepatitis rates for the periods 1968–75 and 1976–82 are given in graphs on "a number of garrisons throughout the country" with three-to sevenfold increases in the latter period compared to that of the earlier period (especially in the prime seasonal period of August/September to December, when 72 percent of the cases are recorded).[45] Significantly differentiated patterns of rises in hepatitis incidence during a year are shown among troops garrisoned in the south of the Ukraine, Belorussia, the Southern Group of Forces (the southern tier of Eastern Europe), and the Group of Soviet Forces in (East) Germany.[46] In addition, a separate graph shows the annual dynamics (seasonality) of hepatitis incidence among troops garrisoned in the north of the European USSR, Central Asia, the Far East and in the Transcaucasus.[47] In sum, while it cannot be determined precisely how much of a rise occurred between periods as shown for the 1968–75 and 1976–82 overall figures cited above, regional monthly incidence rates shown in the latter graphs demonstrate that the incidence of hepatitis is spread throughout the Soviet armed forces, in and out of the country. But the regional differentials could be very high as there is evidence that the rate was more than 10 times higher in Uzbekistan than in Estonia in 1973/74.[48]

Moreover, just as for former typhoid patients who have undergone a course of treatment, former hepatitis A patients remain carriers for an average of 6 months. Very strong negative comments are made on the quality of medical treatment by the authors of this article in the standard military medical source.[49] Attention to the hepatitis problem by the medical system may have contributed to a reported decrease of 24 percent in its incidence relative to the level in 1983.[50] Written in response to an article in *Newsweek* magazine, TASS cites an interview in *Sovetskaya Rossiya* with Aleksey Safonov, then Deputy Minister of Health of the USSR, to refute the allegations. Granting the major reduction in incidence, if my estimate of 1,400,000 is reasonably correct, then there still remains about 1,050,000 cases of hepatitis with which the health authorities must confront.

Perhaps even more worrisome because of the greater seriousness of hepatitis B than those sick with hepatitis A, due to its longer and more debilitating course of recovery, is evidence that even the

elite naval troops are surprisingly much involved at least as carriers of hepatitis B. Thus, 2.3 percent of blood donors of seamen from a number of Soviet naval warships assigned to the Northern Fleet surveyed during 1976 to 1980 (the number of donors is not given in the source) was found to be carriers of hepatitis B.[51] Lt. Col. Zavgorodniy recommended stricter screening of donors to prevent transmission of the disease through blood transfusions to recipients of such infected blood. Further evidence of inadequate medical treatment is given in the February 1983 issue of the *Military Medical Journal.* According to the authors, of 293 patients over one-third retained residual symptoms of hepatitis, about one-tenth had to be rehospitalized, and slightly less than 3 percent developed chronic hepatitis.[52]

The distribution of hepatitis B among civilian blood donors shows that the rate among seamen is at the lower end, but in contrast to the United States all are much higher. Thus, based on sources published in 1977 and 1979, Zavgorodniy gives rates which cover most of the USSR, namely, 1.4 percent in the European USSR, 2.4–2.5 percent in the Urals, Siberia and the Far East, 3.8–6.7 percent in Kazakhstan, 4.9 percent in Central Asia, and 6.1 percent in the Transcaucasus.[53] In contrast, the *Merck Medical Manual* of 1982, notes that less than one-half of 1 percent of the population of the United States is estimated to be hepatitis B carriers, and therefore, the hepatitis B carrier rate for the Soviet seamen alone was about five times the American level.

Absence from duty, as one measure of the cost of the illness, is reported to last 41.3 days on the average, and no less than 1 month (33.1 days) even for light cases.[54] As expected, industrial water pollution is stated to be the primary cause of outbreaks of hepatitis.[55] Pollution of the air as well as water is receiving much more attention in the Soviet Union in Gorbachev's speeches, let alone by medical personnel. Quick rectification of this problem may help solve at least some of these military medical problems related to intestinal infectious diseases.

Meningococcal infections

Commonly found in meningitis and septicemia, the low point seems to have been reached in the USSR between 1962 and 1968, increasing sharply thereafter to the present time.[56] Moscow alone is reported to have had an increase of "50 to 60 times" between 1964 and 1970. A 1982 source stipulates that further increases were recorded during the 1970s. For Tashkent alone, with 1971 equal to 100, then in each year between 1972 and 1978, the index was 300 in 1972, and 600 in 1973, 900 in 1974, 700 in 1975, 900 in 1976, and 400 in both 1977 and 1978. Even with the drop in the last 2 years relative to 1973 to 1976, the incidence of meningococcal infections remained four times higher than in 1971. To the degree that Tashkent represents Uzbeks and the remaining Central Asian population, as the cohort shares from this region increase among potential draftees, this fact alone may contribute to the urgency for solving this and other medical problems before being drafted (given that one report notes that 75 to 80 percent of the national increase occurs among children under 15 years of age), let alone while on active duty. Why the Soviet experience of increases in the inci-

dence lasts some 15 years or so (since 1964, if the Moscow figure is representative of the national picture) is not understood. According to the classic volume on *Control of Communicable Diseases in Man* (its formal title since 1912 when first issued every 5 years thereafter), increases in meningococcal infections come in irregular intervals, lasting 3 to 5 years, not the decade-and-a-half noted here for the Soviet Union.

Within the military service explicitly, Doctor of Medical Sciences and Colonel of the Medical Services I.S. Ivanov, conducted a longitudinal survey of 2,500 patient histories of young soldiers confined to the infection wards of a number of military hospitals during the period 1971 to 1981.[57] The findings showed that the timing of diagnosis and hospitalization thereafter was crucial to the patient's survival or full recovery.

The Ivanov study found that only in 6.3 percent of the cases was the illness diagnosed at the initial stage, i.e. the first twelve hours (marked by an acute onset of general weakness, eyesight affected, absence of appetite, interruption in sleep, strong headache, etc.). Only one-quarter (24.7 percent) were admitted to a hospital the first day of illness, slightly more than one-half (54.3 percent) on the second day, and the remaining one-fifth (21.0) on the third or later day. Death occurred in 1.2 percent of those admitted on the first day, 3.1 percent on the second and 3.4 percent on the third or later day. Recovery rates also were differentiated by day of admission. Incomplete recovery was manifested among one-third of those admitted in the first 12 hours (32 percent), one-half (47.2 percent) of those admitted in the second half of the first day, between two-thirds and three-quarters (70.0 and 72.4 percent, respectively) of those admitted on the second and third day or later. Given that almost 40 percent of those admitted on any day were misdiagnosed, treatment must have been delayed for these soldiers.

Moreover, an article devoted to methodological issues in biomedical statistics published in the June 1984 issue of the *Military Medical Journal*, provides an example of meningococcal illness rates which is so high as to likely not be hypothetical but reflective of reality. Thus, an analysis of data from 130 presumably randomly-chosen new recruits showed that 22 were meningococcal infection carriers. Based on the data given, there was a 95 percent probability that 10.7 to 23.1 percent of the new recruits were carriers![58] In all, meningococcal illnesses must be a major concern to the Soviet military medical service.

CHILDHOOD DISEASES

The pattern of so-called childhood infections in the Soviet Union has changed to record increased numbers of these illnesses among adults, including the military. Diphtheria, mumps and measles, in particular, appear to predominate in military medical writings.

Diphtheria

As noted earlier, the number of diphtheria cases increased by some 7 to 8 times between 1979 and 1983–1985. While some of this increase may have been due to greater recognition by physicians of the possibility of increased occurrence and were thus categorized as

diphtheria, the rise must have been real given recent attention to the issue in the military literature. Perhaps coincidentally with the increased share of recruits from the Central Asian region, a 1981 article reported that among the 611 conscripts from the rural south (therefore more likely to be from among the indigenous nationalities of the region) assigned to one unit, an extraordinarily large proportion was recorded as involved with diphtheria.[59] Thus, during an 11-month study, doctors found that 11 draftees had diphtheria, 33 were carriers and 12 were unclear cases of diphtheria. In all, almost 10 percent, or 56 of the 611 recruits were involved. If this rate is even broadly correct, then combined with the growing proportion of potential recruits from the rural south, this would imply that the national figures for diphtheria illness incidence are very much understated. Even a very approximate estimate demonstrates that much more attention needs to be given to this illness.

In addition, as described earlier for meningococcal infections, proper diagnosis is a major problem among military physicians, and the delay in proper treatment can have very serious consequences. Several studies published in the medical journals of the armed forces report that only from one-tenth to one-third of the diphtheria patients were *correctly* diagnosed before admission to hospitals. Complications, including cardiovascular (myocarditis), nervous system (polyneuritis) and kidney system (nephrosis) problems developed as a result of the delay in diagnosis.[60]

Evidence from a survey of diphtheria among adults conducted over a period of one-and-a-half years (between July 1980 and December 1982), found not only an increase in "recent years" of adult diphtheria, but that every case of toxic diphtheria among those under 20 years of age was a serviceman. And all had come from rural areas—from various republics of the country.[61] Moreover, only 25 percent of those classified as being ill with toxic diphtheria were correctly diagnosed. Complications arose among one of every two of the 21 persons with "sub-toxic" cases, and 24 of the 27 fully toxic cases.[62] Five of those persons whose serious condition was complicated with alcoholism later died. Another unpublicized reason for the anti-alcoholism drive?

Immediate rectification of the situation may be delayed unless other factors leading to counterindications for administration of DPT (diphtheria, pertussis and tetanus) inoculations during the first year of life. According to a major medical journal, 30 to 50 percent of infants in the RSFSR, Latvia and Estonia, and 41 percent in several other republics, did not receive their DPT inoculations at the medically prescribed schedule due to their having other illnesses.[63] If this situation continues, then we may expect further negative reports about this medical issue.

Mumps

Between 1966, the date of last official publication of the incidence of mumps in the USSR, and 1980, the date of my estimate derived from information on the rate per 100,000 population, the incidence of mumps increased by about 50 percent.[64] This trend has affected young military personnel to a sufficient degree, that Professor Postovit, writing in the *Military Medical Journal* of March 1983, stated that "Adults and in particular armed services

personnel of short-term service [i.e. conscripts] also not infrequently suffer from mumps, sufficiently so that it is the basis for calling this infection 'the soldier's disease' ".[65] A remarkable statement. Postovit's study of 168 patients of both sexes indicates that medical complications from this illness can be quite serious. Thus, viral serum meningitis appeared in about 13 to 18 percent of the adults stricken with mumps in his survey, with the mumps virus implicated in 85 percent of the viral serum meningitis cases of all ages.[66] In addition, pancreatitis problems developed among 42 percent of the mumps patients in the sample under study. Again, an area requiring much resources and attention by military medical personnel if they wish to prevent similar depredations of the troops so afflicted.

Measles

Within the population as a whole, measles has been recorded as increasing by over 60 percent between its historic low point of some 286,000 in 1973 and a peak of over 466,000 in 1982. A drop of almost 50 percent the next year (to 233,800) but increases are reported for 1984 and 1985 (to 252,500 and 272,800, respectively).[67] According to one report in *Pediatriya*, in the fall of 1980, "the effect of measles vaccinations was greater in the first years of application than at the present time", perhaps caused by the "nonstandard quality of the vaccine and defects in the vaccination [process]".[68] The *Military Medical Journal* of February 1984 makes this point even stronger. According to this source, among a major outbreak of 18- to 21-year olds "in a collective" some 88 percent of them had received measles vaccinations. Why the quality of vaccines is as low as indicated by these rates of failure indicated in the pediatric and military medical journals may be also due to the lack of refrigeration. According to the publication of the Soviet Institute named for Pasteur, refrigeration, which is necessary for many medications, is either inadequate or lacking and leads to partial loss of biological and immunogenic activeness of the medication or vaccine.[69] Given that in a certain percent of cases, albeit relatively low, measles can lead to serious complications, at the current incidence level, measles remains a serious problem for the Soviet population, including armed services personnel. According to the *Military Medical Journal* of February 1984, in an unspecified city, adults ill with measles reached the national rate of illness prior to the availability of vaccines. Persons in "organized collectives", a euphemism for school groups, but in the context of the publication source, more likely military units, became ill with measles at the astonishing rate of 81.6 percent. Moreover, 99.4 percent of these individuals had been inoculated against measles.[70] Dr. Postovit of the Leningrad Pediatric Medical Institute, in an article published in *Literaturnaya gazeta* in 1985, also refers to the growth of childhood diseases among adults, and adult soldiers in particular.[71] With the incidence of complications fairly high among adult measles patients, undoubtedly due to delays in proper diagnosis of a childhood disease, the prevention of measles among military troops becomes even more germane for any medical authority.

Respiratory diseases

An interview with a leading Soviet specialist on pulmonary diseases indicates that the number of deaths from pulmonary diseases has quintupled between 1960 and 1979.[72] An article co-authored by Academician of Medical Sciences and Major General V.D. Belyakov, in the spring of 1981, found that the prevention of influenza and respiratory diseases was a major issue.[73] Three years later, Professor and Lt. Gen. of the Medical Services Ye.V. Gembitskiy and his colleagues found that "acute pneumonia is one of the most widespread illnesses". Citing national data from the All-Union Scientific Research Institute on Pulmonology of the USSR Ministry of Health, it was noted that the incidence rate was 12 per 1,000 population, which yields some 3,264,000 cases per year.[74] Following the pattern noted earlier of early onset of illness among recent draftees, and implicitly contributing thereby to the number of pneumonia cases cited here, the Gembitskiy article notes that a survey of armed service conscriptees and military construction troops diagnosed with this illness in a "number of medical institutions during 1977–80, found that 19.8 percent were afflicted in their first month of service, 42.2 percent in the first 3 months, 59.3 in their first 6 months, 77.9 percent in the first year, and the remaining 22 percent in their second year of military service.[75] According to their findings 4.2 percent of all recruits came down with acute pneumonia, 6.3 percent manifested various forms of acute respiratory illnesses, and 49.4 percent were ill with non-symptomatic forms of the infection.[76]

Adding to the illness pattern reviewed previously in this paper, and without any reference to alcohol or drug abuse within the military as have been noted recently in the Soviet media, it appears that the varied medical problem of infectious, childhood and respiratory disease pattern described here is of major dimension.

Other Issues Confronting the Soviet Military Medical Service

Several other issues cannot be rectified instantaneously, regardless of the resources devoted to its solution. Included among these issues is the capability of physicians and other medical personnel assigned to the armed forces and to the attitudes of those persons. Only recently has very serious attention been paid to the necessity to reorganize the curriculum and capabilities of all medical personnel, and military medical personnel in particular. Nonetheless, this reorganization and/or retraining of personnel will take time and therefore the medical issues described herein also will take time to resolve.

In June 1986, the draft guidelines for a major new decree on higher and specialized secondary education was published in *Pravda*.[77] One of the early and significant points made in the guidelines for the need to have a restructuring of higher levels of education is "as a result of inadequate clinical training, medical higher education institute graduates are often unable to make a skilled diagnosis and provide the correct treatment".[78] This remonstrance applies in full to Soviet military medical doctors. Information on poor diagnosis has been given earlier, but when arrayed

into tabular format it becomes even clearer that it is not an idle issue.

ERRORS IN DIAGNOSIS OF MAJOR DISEASES

[Reported in Soviet Military Medical Journals, 1982 to 1984—in alphabetical order]

Disease	Incorrect diagnosis rate [1]
Acute ulcers ("VMZh," May 1983, p.57)	38.3 to 62.1
Angina ("VMZh," January 1983, p.16)	94.7
Diphtheria ("VMZh," November 1982, p.35)	68–95
Intestinal infections ("VMZh," August 1983, p.31)	59.7
Measles ("VMZh," August 1983, p.31)	17
Meningitis ("VMZh," December 1983, pp.54–61)	70 to 90
Thyroid cancer ("VMZh," August 1984, p.56)	67.6 to 100
Typhoid ("VMZh," June 1984, p.36 and August 1984, p.38)	42 to 67

[1] In percent.

With error rates at these levels, much work needs to be undertaken to improve health delivery in the Soviet armed forces.

Recognition of a professional, technical and ethical problem among military medical cadres by senior Soviet medical authorities has included the announcement by Komarov of the discharge from service of doctors stationed in the Central Asian, Urals, Trans-Baykal and Far East Military Districts.[79] In January 1986, the *Military Medical Journal* published a summary of the reports given by Kurkotkin, Lizichev and Komarov at the November 1985 "All-Army Conference on the Improvement of Daily Life of Troops and the Tasks of the Medical Services."[80] While much had been improved since the previous meeting on this topic in 1977, much remained to be done. Insufficient supplies are especially noted as are high accident rates in certain military districts.[81] There are continuing problems with sanitation and hygiene, water supply and nutritional and personal hygiene issues.[82] Komarov, in particular, stresses that in military preparedness, "as never before, has there risen such dependence of fighting readiness of units and ships, and the effectiveness of utilization of military arms, on the physical, physiological and psychological possibilities of the individual".[83] After noting the reduction of overall illness rates among officers and men, he also notes the continuing prevalence of intestinal, skin, and respiratory illnesses, shortages of supplies, and the need for drastic improvement in the medical staffs of the military.[84] Throughout 1986, much more comment was made on the need to improve the performance of military medical personnel. And in September 1986, the Party Committee Secretary of the USSR Ministry of Health, in an interview responding to criticisms in *Pravda,* noted, among many other *mea culpa,* that young doctors—obviously also including young military physicians—"arrive at a hospital and sometimes cannot do a simple operation". And, he continues, the level of medical ethics within the profession and branch is very low.[85] Perhaps the single most damning comment on the competence of the beginning physician is found on the front page of the national medical newspaper, *Meditsinskaya gazeta,* in the spring of 1984:

Apparently there exists some unwritten code or stipulation that "protects" the young specialist during the first three years of work. [This attack on the ability of

the young doctor is based on the fact] that [he or she] still needs to fully master resuscitation . . ., is sometimes at a loss on elementary questions of diagnosing acute cardiovascular diseases or acute diseases of the abdominal cavity . . . . Today, post-internship certification is, to all intents and purposes, a rubber-stamp procedure. . . . Why should we have to babysit a mature 25-year old for three years, make allowances for his "youth" and put up with his negligence? [86]

As such, this is a condemnation of the training process, of the attitudes of young doctors, and of the system which allows this to occur. And this statement (of 1984) was made before *glasnost'* became ordained! If we were to combine the explicit comments of the 1984 condemnation of the capabilities of a young physician with the February 1986 comment by the head of the military medical services (Komarov) that young physicians should be required to extend their studies by first being assigned to military hospitals rather than directly to provide medical assistance to the troops, we can appreciate how difficult it will be to improve the quality of medical treatment.[87] Inasmuch as 80 percent of all medical assistance is rendered at the unit level, then a retraining programme might interrupt the flow of services if physicians already on active duty are sent to hospitals for such upgrading of skills. If it is only to be newly assigned young officer-doctors, then it will take many years for the retraining or skill upgrading to be completed. In the meantime, more of the same medical problem could be expected.

Moreover, if the 11 December 1986 *Izvestiya* article cited at the very beginning of this report about increases in medical problems among potential conscriptees will be exacerbated, and Komarov is correct about the dependence of the military on physical and mental health of the troops, then much work needs to be done in the health, educational and military sectors before any major improvement takes place in this area of prime interest.

For these and other reasons the projected important new decision on health services announced by Gorbachev in a September (1986) speech at Krasnodar should provide the outlines of the new direction for the Soviet Union in the health area.[88] Perhaps the "retirement" of Sergey Burenkov as the Minister of Health of the USSR on 29 December 1986 [89] will also clear the way to new efforts in this important area.

Footnotes

[1] The article by V. Shcherban', "Osenniy prizyv", *Izvestiya*, 11 December 1986, p. 3, also provided unusually direct criticism of young persons not wishing to serve in the Soviet military as well as the inability of a number—not cited—who did not pass the Russian language test. I was not aware that a specific language test is administered at the time of induction. But this test is not the basis for rejection from service as are only family problems and medical causes, as well as deferments granted for full-time education only in medical and military higher educational institutions at the present time. While poor Russian language ability may not be a cause for rejection from military service, it could be the basis for determining the branch of service to which the individual is assigned. Also see, Natalie Gross, "How Healthy is the Soviet Soldier?", in *Soviet Analyst*, 16 April 1986, pp. 3-5. I am indebted to Ms. Gross of the United States Army Russian Institute for her assistance in reviewing some of the basic materials underlying the present contribution, as well as my research associate, Ms. Carolyn Zeller, of Georgetown University. This paper is part of a larger study on health and quality of life in the USSR, prepared for the Office of Net Assessment, US Department of Defense.

[2] From *Magyar Hirlap*, 27 June 1986, cited in "The Hungarian Soldier: Unwilling and Unfit", in Radio Free Europe, 4 August 1986 (RAD/Grossman) pp. 1-2. According to Hungarian radio, cited by Radio Free Europe, a further 3 to 4 percent had to be discharged before their tour of duty was completed for health reasons. The reasons cited are nervous and mobility disorders, cardiovascular and circulatory diseases as well as digestive illnesses.

[3] Cf. V.F. Mikhal'chuk and G.A. Kargopolov, "Metodicheskoye soveshchaniye po voprosam organizatsii ozdorovitel'noy raboty sredi doprizyvnoy i prizyvnoy molodezhi;", *Voyenno-meditsin-*

skoy zhurnal (hereafter *VMZh*), No. 2, February 1983, p. 80, and L.I. Korsakov and B.N. Almazov, "Nekotoryye aspekty sotsial'no-meditsinskogo izucheniya yunoshey doprizyvnykh vozrastov", *Ibid*, No. 6, June 1983, pp. 22-24.

[4] Among others, see Murray Feshbach, "Health in the USSR—Organization, Trends and Ethics". Paper prepared for the International Colloquium "Health Care Systems. Moral Issues and Public Policy", 23-26 July 1985, Bad Homburg, West Germany. To be published by D. Reidel and Company, 1987. Edited by Robert U. Massey and Hans-Martin Sass.

[5] See BBC, *Summary of World Broadcasts, USSR*, 25 June 1986, p. SU/8294/C/3. The actual broadcasts were 1245 and 0815 gmt, respectively.

[6] Cited in "A Physician's Responsibility", *Sovetskaya Rossiya*, 30 June 1984; cited in Feshbach, "Health", forthcoming. Apparently insufficient progress has been made between the June 1984 article and the Burenkov Broadcasts.

[7] For example, see Yu. P. Lisitsyn and V.K. Ovcharov, In *Vestnik Akademii meditsinskikh nauk SSSR*, No. 11, November 1981, pp. 33-40; General Secretary Yu.P. Andropov's statement at the Plenary Session of the Central Committee of the CPSU Meeting of 15 June 1983, cited in *Pravda*, 16 June 1983, pp. 1-2; A.G. Aganbegyan, "The Strategy of Accelerating Socioeconomic Development", *Problemy mira i sotsializma* No. 9, September 1985, pp. 13-18, where he stresses the need for considerable additional resources to protect health and meet other needs; and the speech of Burenkov, as member of the Supreme Soviet of Nationalities on 18 June 1986, to the effect that in the 11th five-year plan period, the USSR Ministry of Health failed to take exhaustive measures to eradicate many serious shortcomings in the work of health organs and institutions. In "Abbreviated Report", *Izvestiya*, 21 June 1986, p. 2.

[8] See *Moskovskaya Pravda*, 15 February 1986, p. 2, in JPRS, *USSR Biological and Biomedical Affairs*, UBB-86-008, 9 May 1986, p. 105.

[9] *Meditsinskaya gazeta*, 1 February 1986; *Ibid.*, 26 February 1986; *Bakinskiy rabochiy*, 18 February 1986; *Pravda vostoka*, 9 August 1986; and especially "Supreme Soviet Preparatory Commission Discusses Problems in Health Service", in BBC, *Summary of World Broadcasts, USSR*, Moscow Home Service, 1400 gmt, 10 June 1986, pp. SU/8285/B/3-5. Also see Celestine Bohlen's article describing the ills of Moscow medical services, in *The Washington Post*, 7 November 1986.

[10] See Chief Pharmacist of the Soviet military, Major General of the Medical Services, V. Tyurin, "Vnedryat' i ratsional'no ispol'zovat' meditsinskiye sredstva", *Tyl i snabzheniye Sovetskikh vooruzhennykh sil*, No. 3, March 1984, p. 53.

[11] Ye.T. Tadzhiyev, "O sostoyanii zdorov'ya detey rannego vozrasta", *Zdravookhraneniye Tadzhikistana*, No. 6, November-December 1981, p. 80. The author is the head of the Social Hygiene and Health Organization Department of the Tadzhik State Medical Institute.

[12] M.A. Avazov, "Dinamika smertnosti naseleniya Tadzhikskoy SSR", *Ibid*, No. 6, November-December 1983, p. 77.

[13] I.M. Virganskaya, "K voprosu o predstoyashchey prodolzhitel'nost' zhizn' v trudosposobnom vozraste", *Zdravookhraneniye Rossiyskoy Federatsii*, No. 7, July 1984, p. 24.

[14] L.P. Shakhot'ko, *Vosproizvodstvo naseleniya Belorusskoy SSR*, Minsk, Nauka i tekhnika, 1985, and Public Health Service, National Center for Vital Statistics, *Vital Statistics of the United States, 1983, Life Tables*, Volume II, Section 6, DHHS Publication NO. (PHS) 86-1104, Hyattsville, Md., September 1986. As this present paper was undergoing final typing for submission, I was told that new age-specific death rates for the USSR as a whole had just been published in *Vestnik statistiki*, No. 12, December 1986. It has not been possible to incorporate an analysis of these data given stringent time constraints.

[15] "Il faut extirper la saleté jusqu'au bout", *Le Monde*, 16 July 1986.

[16] *Pravda*, 10 July 1986.

[17] *Ibid*, 15 January 1986, p. 1.

[18] "V interesakh zdorov'ya voinov", *Krasnaya zvezda*, 7 January 1984, p. 1.

[19] The quality of vaccines also needs to be supplemented by proper handling, maintenance and administration. The shortage of needles, and their reuse, is only one aspect of the issue raised by this article. Also see *Meditsinskaya gazeta*, 14 July 1983, p. 1; and 14 December 1983, p. 1. Also see Murray Feshbach, "Issues in Soviet Health Problems", in Congress of the United States, Joint Economic Committee, *Soviet Economy in the 1980s: Problems and Prospects*. Part 2, 97th Congress, 2nd Session. Washington DC, US Government Printing Office, 31 December 1982, pp. 210-212.

[20] According to an analysis and report on a samizdat document prepared by Elizabeth Fuller of Radio Liberty, some 350 Armenian intellectuals transmitted to General Secretary Gorbachev detailed comments on environmental pollution in their republic. Included in their statement were data on the medical consequences of this pollution. Apparently they had access to figures which show that over the two decades, 1965 to 1985, astonishing increases in cancer illness rates occurred, amounting to a fourfold increase. Moreover, a claim is made that in 1970 to 1985 ("the last fifteen years"), it also was recorded that "the number of mentally retarded children had risen fivefold; the incidence of mental illness sixfold; that of leukemia fourfold; and that of abnormal and premature births sevenfold". More details are given in Elizabeth Fuller, "Is Armenia on the brink of an Ecological Disaster?", in USIA, *Addendum*, prepared by the Press and Publication Service, No. 37, 12 September 1986, pp. 35-40, especially pp. 35-36.

[21] TsSU SSSR, *Narodnoye khozyaystvo SSSR v 1985 godu, statisticheskiy yezhegodnik*, Moscow, Finansy i statistika, 1986, p. 454, for 1984 and 1985, and previous issues of the yearbook for the earlier years. Figures for the United States, with a population slightly lower in number than in the Soviet Union, roughly 240 and 280 millions, respectively; the number of cases reported in 1983, 1984 and 1985, are 2, 1 and 1. The Centers for Disease Control have not recorded a single case in the first 10 months of 1986, the last date available at the time of writing.

[22] Centers for Disease Control, *Morbidity and Mortality Weekly Report*, Vol. 35, No. 46, 21 November 1986, p. 716.

[23] For more details, see Murray Feshbach, "Issues", 1982, pp. 203-227, especially pp. 203-221.

[24] F.I. Komarov, "Osnovnyye itogi deyatel'nosti voyenno-meditsinskoy sluzhby v desyatoy pyatiletke i zadachi po dal'neyshemu sovershenstvovaniyu meditsinskogo obespecheniya armii i flota", *VMZh*, No. 1, January 1981, p. 7.

[25] V.I. Agafonov and I.S. Reshetnev, "Preduprezhdeniye zanosa karantinnykh i drugikh infektsionnykh zabolevaniy", *Ibid*, No. 6, June 1980, p. 41. Why did the authors feel it necessary to cite the reduction or elimination of epidemic typhus, asiatic cholera, smallpox and the plague? Since several of these diseases are also mentioned subsequently by other medical authorities, perhaps the announcement of their total elimination in previous years by Soviet medical authorities was premature.

[26] V.D. Belyakov, "Programmno-tselevoye planirovaniye i upravleniye protivoepidemicheskoy sistemoy", *Ibid*, No. 10, October 1981, pp. 16-19.

[27] *Ibid*, No. 1, January 1982, p. 75.

[28] Published on 27 December 1981, p. 1.

[29] *Ibid*.

[30] R.A. Marasanov, "XXX rasshirennyy plenum Uchenogo meditsinskogo soveta TsVMU MO i soveshchaniye rukovodyashchego sostava meditsinskoy sluzhby Vooruzhennykh Sil SSSR", *VMZh*, No. 1, January 1983, p. 78.

[31] *Ibid*, p. 79.

[32] A.I. Sorokin, "Vooruzhennyye sily razvitogo sotsializma", *Voprosy filosofii*, No. 2, February 1983, pp. 3-13, especially pp. 9-10.

[33] V. Chevyrev, "Zadachi sanitarnogo nadzora", *Tyl i snabzheniye Sovetskogo vooruzhennogo sila*, No. 5, May 1984, p. 44.

[34] *Ibid*, p. 45.

[35] *Ibid*, p. 46.

[36] *Ibid*.

[37] *Ibid*.

[38] From all causes. The article then elaborates problems related to sepsis as a cause of illness. G.N. Tsybulyak et al, "Lecheniye bol'nykh sepsisom", *VMZh*, No. 9, September 1982, p. 25.

[39] For a detailed listing of scientific research needed for the armed forces, see A.I. Sidel'nikov, "Metodika provedeniya voyenno-nauchnoy raboty", *Ibid*, No. 2, February 1983, p. 20.

[40] Editorial, "Puti dal'neyshego povysheniya effektivnosti i kachestva profilaktiki ostrykh kishechnykh infektsiy v voyskakh", *VMZh*, No. 6, June 1984, p. 3. According to an ex-Soviet military doctor who served in 3 military districts in the USSR, about one-half of all conscripts complete their tour of duty with intestinal problems. The same proportion (one in every 2 soliders) was ill with dysentery at least once during his two years of service, and one of every 3 soldiers, twice. I am indebted to Ms. Natalie Gross for supplying me with this information from a talk delivered by the Doctor.

[41] Ya.A. Luk'yanov, "Bakteriologicheskiye metody diagnostiki ostrykh kishechnykh infektsiy", *Ibid*, No. 8, August 1982, p. 31.

[42] V.I. Agofonov et al, "Epidemiologiya tifoparatifoznykh infektsiy i ikh profilaktika v voyskakh", *Ibid*, No. 6, June 1984, pp. 36-40, cited in Natalie Gross, "Infectious Diseases in the Soviet Army: Recent Trends", Student paper prepared at the US Army Russian Institute, summer 1984.

[43] "Puti", *op.cit.*, 1984, p. 6.

[44] See Murray Feshbach, *Compendium of Soviet Health Statistics*, Study prepared for the US Bureau of the Census, CIR Staff Paper, No. 5, January 1985, p. 79 and based on information in I.A. Blyakher, "Seminar po problemam virusnykh gepatitov", *Zdravookhraneniye Tadzhikistana*, No. 3, May-June 1984, pp. 103-104.

[45] V.I. Agafonov et al, "Osnovnyye napravleniya sovershenstvovaniya profilaktiki virusnogo gepatita A v voyskakh", *Ibid*, No. 10, October 1983, pp. 38 and 39. Agafonov is an Honoured Doctor of the RSFSR, Doctor of Medical Sciences, and Major General in the Military Medical Services.

[46] *Ibid*, p. 37. Hungary and East Germany also are shown in the chart.

[47] *Ibid*, p. 38.

[48] Given as 627.6 per 100,000 population in Uzbekistan and 61.9 per 100,000 in Estonia, in V.A. Lebedinskiy and N.S. Garin, "Epidemiologicheskoye znacheniye latentnykh form infektsionnykh zabolevaniy", *Ibid*, No. 3, March 1982, p. 37.

[49] *Ibid*.

[50] TASS, in English, 0820 gmt, 21 July 1985; in FBIS, *USSR Daily Report*, 23 July 1985, p. R4.

[51] G.N. Zavgorodniy, "Vyavleniye nositel'stva virusa gepatita B u bezvozmezdnykh donorov na korablyakh", *Ibid*, No. 11, November 1982, p. 44.

[52] 35, 9 and 2.8 percents, respectively, given in V.A. Shalygin and Z.S. Zemlyanaya, "Effektivnost' dispensarizatsiya perebolevshikh virusnym gepatitom", *Ibid*, No. 2, February 1983, p. 67.

[53] Zavgorodniy, *loc.cit.*

[54] *VMZh*, No. 7, July 1982, p. 35.

[55] *Ibid*, No. 5, May 1982, p. 40.

[56] D.M. Khashimov and O.Kh. Khusainov, "Nekotoryye kliniko-epidimiologicheskiye osobennosti meningokokkovoy infektsii za poslednyy desyat' let v Dushanbe", *Zdravookhraneniye Tadzhikistana*, No. 5, September-October 1979, pp. 52-54; and others.

[57] K.S. Ivanov, "Rannyaya diagnostika i neotlozhnaya pomoshch' pri meningokokkovoy infektsii", *Ibid*, No. 12, December 1983, pp. 59-62, especially pp. 59-60.

[58] A.A. Degtyarev et al, "Metody statisticheskogo analiza v rabote voyennogo vracha", *Ibid*, No. 6, June 1984, p. 72.

[59] V.V. Dalmatov et al, "Difteriya v organizovannykh kollektivakh molodykh lyudey", *VMZh*, No. 10, October 1981, p. 71.

[60] Among others, see V.V. Pushnya, "Rannyaya diagnostika difterii zeva v vzroslykh", *Ibid*, No. 1, January 1982, p. 42; "Klinika i diagnostika oslozhneniy pri difterii zeva u vzroslykh",

Ibid, No. 11, November 1982, pp. 35–36; and M.Kh. Dudoy et al, "Oshibki v diagnostike difterii u vzroslykh", *Ibid*, No. 3, March 1983, p. 59.

[61] V.I. Pokrovskiy et al., "Difteriya u vzroslykh", *Sovetskaya meditsina*, No. 11, November 1984, pp. 89 and 90. No hint is given whether these "various republics" were located only in one region or spread throughout the entire country. If the former, it reinforces the point made earlier about the 611 new recruits from the rural south.

[62] *Ibid*, p. 92.

[63] *Zhurnal mikrobiologii, epidimiologii i immunologii*, No. 6, June 1984, p. 7.

[64] From 621,371 cases reported in 1966 to an estimate of 911,000 in 1980. See Murray Feshbach, *Compendium*, 1985, p. 81.

[65] V.A. Postovit, "Epidemicheskiy parotit u vzroslykh", *VMZh*, No. 3, March 1983, p. 38.

[66] *Ibid*, p. 40.

[67] Murray Feshbach, *Compendium*, 1985, p. 78; and TsSU, *Nar. khoz. v 1985*, 1986, p. 545.

[68] *Pediatriya*, No. 9, September 1980.

[69] Trudy Instituta Pastura, 1982.

[70] A.I. Tkalich and V.L. Marder, "Protivoepidemicheskiye meropriyatiya pri kori u vzroslykh", *VMZh*, No. 2, February 1984, p. 35.

[71] Cf. *Literaturnaya gazeta*, 21 August 1985, p. 13.

[72] Private communication from Rosemarie Crisostomo.

[73] V.D. Belyakov and D.T. Khokhlov, "Perspektivy razvitiya immunoprofilaktiki v voyskakh", *VMZh*, No. 5, May 1981, p. 48.

[74] Dividing by the 1983/84 population of 272,000,000. See Ye.V. Gembitskiy et al, "K voprosu o pervichnoy profilaktike ostroy pnevmonii u voyennosluzhashchikh srochnoy sluzhby", *Ibid*, No. 1, January 1984, p. 29.

[75] *Ibid*.

[76] *Ibid*, p. 30.

[77] 1 June 1986, pp. 1–3.

[78] *Ibid*, p. 1.

[79] F. Komarov, "Meditsinskim kadram—zabotu i vnimaniye", *Tyl i snabzheniye Sovetskikh vooruzhennykh sil*, No. 6, June 1984, p. 41. Also see Lisitsyn's article in *Sovetskiy voin*, No. 11, June 1985, pp. 14–15.

[80] See *VMZh*, No. 1, January 1986, pp. 3–13.

[81] *Ibid*, p. 6.

[82] *Ibid*, p. 8.

[83] *Ibid*, p. 9.

[84] *Ibid*, pp. 10–12.

[85] A. Chernyak, "Party Life: Health Is More Precious Than Wealth—Letters From Ministries and Departments", *Pravda*, 15 September 1986, pp. 1, 3, abstracted in *The Current Digest of the Soviet Press*, Vol. XXXVIII, No. 37, 15 October 1986, p. 21.

[86] N. Kaverin, "Your Opinion, Doctor? Without Allowances for Youth", *Meditsinskaya gazeta*, 16 March 1984, p. 1.

[87] See F. Komarov, "Kurs na profilaktiku", *Krasnaya zvezda*, 1 February 1986, p. 2.

[88] "We are embarking upon a serious improvement of all our health services. You will soon have the documents and will learn about it." FBIS, *Daily Report: Soviet Union*, 19 September 1986, p. R5.

[89] BBC, *Summary of World Broadcasts: USSR*, 30 December 1986, p. SU/8452/i. Two deputy ministers of health, Burgasov and Safonov also found it appropriate to retire earlier in the month. *Pravda*, 5 December 1986.

COMMENTARY

By Andrew W. Marshall*

What burden Soviet defense and related programs impose on the Soviet economy and society is an important question. Good estimates of the full economic cost and future economic consequences of these programs would be extremely useful in thinking about U.S. policy and in analysis of the likely future evolution of the Soviet economy and society. Here I am taking the perspective of an outside interested observer. There is another perspective, that of the Soviet leadership, which I will mention briefly below.

While good estimates of the burden and costs of Soviet military programs have always been important, they are, perhaps, even more so now. This is because of the evident poor performance of the Soviet economy, which it would be useful to understand more fully. Any analysis of the performance of the Soviet economy should be informed by an estimate of the impact of the very substantial Soviet military effort of the last twenty years and more. Indeed, if the burden measured in terms of the percentage of GNP is as high as I think it plausibly could be estimated, it has to be considered as a contributing factor in the decline of the general economic performance.

Unfortunately, we do not have measures of the burden that are as comprehensive as they ought to be, or in whose accuracy we can have high confidence. Partly, this is a matter of the way we have defined what it is we are measuring. The definition of what should be included as military or military related that has been used in most Western analyses is too narrow to encompass Soviet practices. Moreover, our measures of the economic cost often fail to take account of the full impact of Soviet military programs on the rest of the economy. The result is that current assessments of the burden are probably too low. To be sure, the task of providing more adequate measures of the burden would be very difficult and complex, but few if any attempts have been made.

Additional difficulties arise if we try to understand how the burden of military programs is seen by top Soviet officials. Even to state the issue this way probably distorts the Soviet perpective. The Soviet military program is probably not seen as a cost or burden or diversion of resources from other more highly valued uses. The Soviet state has as one of its goals the enhancement of Soviet power generally and of Soviet military capabilities in particular. This is not a minor difference from the perspective of people in the West. For the Soviet leadership, the measure of economic success is not the satisfaction of the population as a whole, but the level and

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rate of growth in military capability and, more generally, in the achievement of a favorable correlation of forces.

As a means to that end, however, Soviet officials must consider the trade-offs between current and future capabilities and the appropriate long term balance between investment and military programs. But Soviet accounting practices may not show the full economic cost of military programs. How the Soviet officials see these trade-offs depends on how the books are kept and whether in addition to the normal accounts there are periodic studies of the full costs of the subsidies and the resources that flow to the Soviet military through a variety of indirect channels. I mention this other perspective only to indicate some of the dimensions that a full analysis of the burden of Soviet military programs could include.

How might an outside interested observer go about estimating the burden? It seems useful to think of the Soviet military effort as consisting of three tranches. The first includes the most clearly and narrowly military programs, i.e., the men, equipment, military R&D, the military portion of the space program, the atomic weapons program, etc. The second tranche consists of additional resource flows to military purposes not included in the first tranche, e.g., civil defense, industrial mobilization preparations, dual use investments, etc. The third tranche is the cost of the external empire, costs that are undertaken for purposes of increasing protection of the Soviet Union and/or for the expansion of its influence in the world. Each tranche poses distinctive problems of cost estimation. The base for further exploration would be estimates for the past 20 to 30 years of each tranche. A further step would be to analyze the impact of this allocation of resources to military and related programs on the future performance of the economy or on specific sectors within it. Doing this would require a good model of how the Soviet economy works, or at least a very good understanding of how the effects of the resource constraints in other programs caused by the allocations to defense are propagated throughout the economy. To investigate the future one would have to make alternative assumptions as to allocations to each tranche.

Let me take each of these tranches in order and indicate some of the problems in estimating the full economic cost of the Soviet military programs in any particular year or period of years. With respect to the first tranche the problem of costing at one level is very clear cut. There are so many men, certain kinds and numbers of equipment, and supporting programs, and one can try to estimate their cost. But it is questionable whether our estimates of the ruble cost of these programs can accurately capture their full economic cost. Apart from the standard concerns about Soviet prices, some emigres suggest that in industrial organizations that produce both defense and nondefense goods the overhead costs are allocated in such a way as to favor defense production and thereby underestimate its full cost. Moreover, the Soviet military may obtain the highest quality portion of various products and pay no premium. When supply bottlenecks arise, the military industries may receive preferential deliveries, with delays being absorbed by the other parts of the economy. The cost to the rest of the economy in less efficient production is difficult to estimate.

The denominator for calculating the burden of this tranche and the others is an estimate of Soviet GNP, which may need to be revised. I refer here to articles by G. Khanin which suggest that western estimates have overstated recent Soviet growth.[1] A downward correction of GNP would, of course, increase estimates of the percentage of GNP allocated to the military.

The second tranche covers a number of programs by which the Soviet military acquires resources for its use or influences the allocation of resources in ways that make them useful to the military should some emergency or war occur. It includes programs such as civil defense, the protection of industry, and industrial mobilization preparations. Some of the more interesting examples that would be included raise questions of joint use and the allocation of costs. The BAM railroad should in part be seen as a program for the development of the military logistic support infrastructure in the Far East. Some portion of its construction and perhaps other costs need to be allocated to the military. Aeroflot aircraft have some of their design characteristics dictated by the military, some of which reduce the operating efficiency of the aircraft. Not only the investment costs of these additional features, but the increased operating costs over each aircraft's life time should be attributed to the Soviet military.

The Soviet merchant marine has its ship designs influenced by military requirements, and on a day-to-day basis some portion of its vessels is allocated to servicing the Soviet Navy. In contrast to the U.S. Navy, which buys and paints gray the support ships that it needs for current operations, the Soviet Navy makes extensive use of the merchant marine. Some of the ships in the merchant marine are designed for transport of troops and have a number of special features that allow this. Perhaps the most interesting example of the degree to which the Navy influences other organizations' use of resources is the following. Some years ago the fishing industry in collaboration with people in one of the Leningrad shipyards developed a plan for a tanker fleet to support the worldwide operations of the fishing fleet. This plan included the design of a tanker and specified the number of tankers in the proposed fleet. The plan was reviewed by the Navy, which proposed that three ship designs of varying tonnage and fueling capacity be included and that the total capacity of the tanker fleet be doubled. The fishing industry merely asked whether the Navy would support in the appropriate forums the allocation of the resources and building space needed to carry out this program. When assured that the Navy would do so, the fishing industry forwarded the revised plan to the economic planners. The Navy gets to use these tankers for its current operations and has them available in future crises or war, but the expenditures show up in the fishing industry's budget.

The third tranche includes the cost of empire, principally economic and military aid and subsidies to Soviet satellites and clients. While these costs are not entirely to be written off as military, they are incurred in part for the sake of Soviet national security and the increased power of the Soviet state. Like the more nar-

[1] See in particular V. Selyunin and G. Khanin. "Cunning Figures," *Novyy Mir*, Feb. 1987

rowly military programs, these activities compete for resources with Soviet investment and consumption. Charles Wolf and others at Rand have made estimates for the period 1971 through 1983 and conclude that the cost of the empire are far from negligible, averaging about 4 percent of GNP over this period.[2]

It is difficult to estimate what the total of all three tranches might be. My guess is that they comprise somewhere between 20 and 30 percent of Soviet GNP in the last 10 years. If the diversion of resources to military and other major national security/foreign policy objectives is in fact of this magnitude, it may help to explain the decline in the rate of growth of Soviet GNP. It clearly is not the only cause. Important questions are: Has this burden been growing in the past? If it has, must its growth be constrained in the future? Must it be reduced in order to free resources for investment and for consumption?

Past modeling of the Soviet economy has not sufficiently accounted for so substantial a diversion of resources to the military and related programs. The models do not reflect the inter-penetration of the military into the other sectors of the economy that I have mentioned in describing the second tranche. This suggests that there are aspects of the modeling that may need to be changed in the future.[3]

There may also be some delayed effects of the Soviet military burden that should be considered. The Soviet Union may face requirements to invest in areas previously neglected, in part because of the large allocation of resources to the military—examples may be the health problems the Soviet are experiencing, and environmental pollution problems. They may have to address these problems in the future for many reasons, including their impact on the future performance of the economy. A full assessment of the burden might thus turn to consideration of areas of potential investment that will be required in the future because of the underinvestment that has taken place in the past.

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[2] Charles Wolf, et al, *The Cost of the Soviet Empire*, Rand Corporation, Sept. 1983, R-3073/1-NA; and *The Costs and Benefits of the Soviet Empire*, 1981-1983, Rand, Aug. 1987, R-3419-NA.

[3] See Gregory G. Hildebrandt, Editor, *Rand Conference on Models of the Soviet Economy*, October 11-12, 1984, Rand, October 1985, R-3322, especially sections VII and VIII which discuss possible future directions that modeling might take.

COMMENTARY

By Norbert D. Michaud, Stephen O. Maddalena, and Michael J. Barry*

Since 1965, when the present machinebuilding and metal working (MBMW) ministerial system was established, the output of the military MBMW ministries has expanded at a faster rate than the civil MBMW ministries. Although the military MBMW ministries will continue to grow as fast in the 12th Five Year Plan (FYP) as in the previous plan period, the Soviets have decided for the first time to expand the civil machinery ministries as fast as the military machinery ministries. Published data on the 12th FYP reveal that the planned growth for the civil MBMW ministries will be the same as planned growth for the MBMW branch as a whole and therefore equal to that of planned growth in the military MBMW ministries.

In Gorbachev's economic program, the various MBMW ministries are the responsible centers for modernizing industry—for technological innovation and for improving the quality of products and the productivity of resources. They are the source of new production equipment and final durable goods (both civil and military). Thus, machinery producers are the focus of much attention for planned allocations or reallocations of critical resources in the 12th FYP.

There are twenty Soviet MBMW ministries.[1] Nine are explicitly identified as military ministries, having as their primary orientation the production of military equipment. Because of their importance to national security, their growth patterns are seldom reported. In contrast, the growth rates of the individual civil ministries, like the MBMW total, are reported in terms of rates of increase in their gross value of output (GVO) in 'comparable', or Soviet constant, prices on a monthly basis.[2] Gorbachev's emphasis on the civil MBMW ministries as the key to future economic growth has unleashed an unprecedented flood of statistics and plan data. For the first time, a FYP target was published for the growth of the civil MBMW ministries as a group—43 percent.[3] The first draft plan originally called for civil MBMW output to grow by 24 percent, but this was raised in the wake of Gorbachev's modernization program and the vital importance of the civil MBMW ministries in accelerating Soviet economic growth. The current civil MBMW target of 43 percent is consistent with an estimate based on the

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*Defense Intelligence Agency. This paper represents the views of the authors, not those of the DIA of the U.S. Government.

[1] The number was reduced to eighteen in July 1987 when four civil MBMW ministries were consolidated into two ministries.

[2] The reporting of these statistics has been discontinued in 1987.

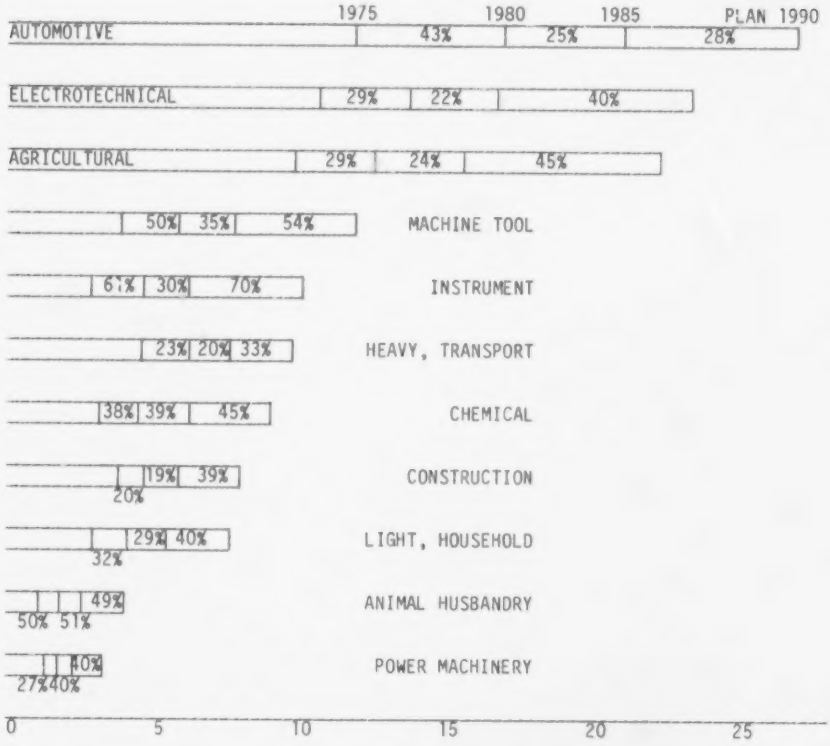
[3] *Plannovoye Khozyaystvo*, Sept. 1986, p. 18.

published planned growth rates and estimated shares of output of each of the civil ministries.

The planned growth in output among the civil MBMW ministries for 1986–90 indicates a general continuation of the relative priorities within the civil MBMW ministries of the previous ten years. According to planned growth in gross value of output, the instrument-making and the machine tool ministries will continue to expand the fastest. The ministry showing the lowest planned growth is the automotive industry, yet it remains the largest civil ministry in terms of output because of its rapid expansion in the last twenty years. (See Chart 1.)

CHART 1

SOVIET CIVIL MBMW MINISTRIES:
GROSS VALUE OF OUTPUT AT END OF FIVE YEAR PERIODS
(Percentage Increase)



BILLION OF 1982 COMPARABLE RUBLES

SOURCES: 1965-78 Level and Trend of the Gross Valve of Output in the Soviet Defense Machinery Ministries, DIA DDB-1910-4-79, July 79

1979-85 Ekonomicheskaya Gazeta (monthly issues); unpublished table prepared by the Federal Research Division of the Library of Congress

1985-90 Technologiya I Organizatsiya Proizvodstva, No. 1, Jan 1986, pp. 1-4, JPRS-UMM-86-009, 28 April 1986
Mashinostroitel', No. 2, February 1986, p. 8
Voprosi Ekonomiki, No. 1, Jan 1986, pp. 3-13, JPRS-UST-86-011-L, pp. 1-12

The recently published 12th FYP shows total machinery output—all 20 ministries—growing 43 percent during 1986–90.[4] Since planned growth for the civil MBMW ministries are already known, it is a straightforward calculation to estimate planned military MBMW growth. Military MBMW output will also increase 43 percent, or not much different from its 41 percent growth during 1981-85. Some of the military ministries have been identified as priority and will most likely grow much faster than the average.

The electronics industry is planned to increase 30–60 percent faster than the entire MBMW branch, or by about 56–59 percent.[5] The electronics ministry, a military ministry, has been identified as a key player in the modernization program so this growth rate is not unexpected and not unusual for a military ministry. The radio industry, also a military MBMW ministry, reportedly grew between 1980 and 1983 at a 12 percent annual rate which, if extended through 1985, yields a 76 percent increase over the 1981–85 period.[6] This is most likely close to its plan for the 1986–90 period judging by the similarity of planned growth for military MBMW ministries in the 12 FYP and actual growth in the previous five year period.

While the civil and military MBMW sectors will be expanding at similar rates through 1990, this will represent a larger rate of increase for the civil sector than for the military sector. During the 11th FYP period, military MBMW ministries grew 41 percent while civil MBMW ministries grew 26 percent. Thus, while military MBMW output during the 12 FYP is to grow at about the same rate achieved during the 11th FYP, civil machinery is scheduled for a sharp increase to 43 percent. This is in line with Gorbachev's call for a 1.5 to 2 fold increase in civil machinery growth rates.

TABLE 1.—SOVIET MBMW BRANCH: GVO GROWTH RATES

[In percent]

	1976–80	1981–85	1986–90
MBMW total	48	35	43
Civil MBMW ministries	35	26	43
Military MBMW ministries	61	41	43

Capital investment in the 12th FYP will be increased over the 11th FYP in both the military and civil MBMW sectors. The civil MBMW ministries are to receive 63 billion rubles in capital investment, an 80–90 percent increase. Investment in the military MBMW ministries is not expected to grow nearly as rapidly. As a result of the more rapid rise in civil MBMW investment, the civil share of total MBMW investment will be slightly higher than in the 10th or 11th FYP thus lowering the share of the military MBMW branches. Four civil MBMW ministries have been identified as targets of particularly large increases in investment; precision instruments (250 percent), machine tools (140 percent), agricul-

[4] Politizdat, 5 March 1986, p. 28.
[5] Ibid, p. 28.
[6] *Sotsialisticheskiy trud*, No. 6, June 1985, p. 117.

tural machinery (120 percent) and electrical equipment (100 percent).

What little increase in labor force will occur in the whole economy is being directed almost totally to the service sector. In the MBMW sector, with only one percent or less increase in labor planned, the increases in output are expected to result from increases in productivity due to new capital investment and very intensive use of new machinery. Higher prices on the new equipment will also contribute to the growth in the value of output of new equipment. High prices covering the higher cost of new production technologies and advances in product quality will result from having to use higher paid technical workers, more costly materials or components, better equipment and more complex processes. One Soviet article suggests that 30 of the 43 percentage-point increase in growth might be expected to result from the high introductory prices on "new" products.[7]

As a result of the similarity of growth rates in the 12th FYP, the proportions of output from the civil and military MBMW ministries will not change appreciably. The civil MBMW ministries account for 44 percent of total MBMW GVO and military ministries 56 percent. However, the defense ministries produce many civil goods and civil ministries produce many goods for the military, and it is possible that the civil/military mix of final products could change. Unless this change in product mix is significant, the published statistics would probably not reveal any shift in civil/military product orientation in the machinery sector.

TABLE 2.—MILITARY MINISTRY SHARES OF MBMW BRANCH*

[In percent]

	1971–75	1976–80	1981–85	1986–90
Gross value of output	50	52	56	56
Investment	50	62	58	48–52
Labor force	59	60	62	62

*Residual derived by deducting statistics and estimates on civil ministries from the MBMW branch total to represent defense ministries; also includes nonministry branch activities estimated to comprise 10–15 percent of the residual.

Until very recently, Gorbachev like his predecessors had called on civil MBMW ministries only to emulate the defense sector, particulary its management, rather than call on the military MBMW to provide resources to the civil sector. Gorbachev's call was eventually followed by a number of transfers of top defense industrial managers to higher government and party posts overseeing the economy, but there was little evidence of any resource switches or revisions to civil production targets in defense ministries. Recently, however, there have been increasing calls for the military MBMW sector to assist the civil sector. The 12th FYP published in June 1986 called for the defense industry to provide advanced machine tools to help modernize light industry, and Soviet statements suggest the possibility that there may be more emphasis on civil production in the defense industry than before.

[7] Novyy Mir, No. 2, Feb. 1987, p. 188.

The defense sector is likely to benefit from the development of key high-tech industries. The four sectors identified in Gorbachev's modernization plan for special attention—electronics, computers, instruments, and electrical equipment—are also identified by military leaders as key to modernization of the defense industrial sector. While some civil ministries have already been affected by the reduction in labor due to the transfer of unskilled labor to more productive arenas there is no indication that this has occurred in the defense ministries. Technical workers, said to be in short supply, are reportedly to be reallocated to key ministries, most likely to those critical sectors listed above.

V. ENERGY SUPPLY AND CONSERVATION

OVERVIEW

By John J. Schanz, Jr.*

The four papers in this section each take a specific facet of the Soviet energy situation and examine it in detail. Jonathan Stern reveals the difficulties and uncertainties of forecasting petroleum production. This is of particular interest because of its relationship to the future Soviet exports of oil and gas. In its search for ways to ease the burdens on oil development, the Soviet Union will now seek to develop its Eastern coal basins. David Warner and Louis Kaiser highlight the many technological challenges this will present. Judith Thornton explores the question of whether or not the future rate of growth in electric power will be adequate and how the response to the events at Chernobyl might influence this outlook. Conservation has now moved up among the Soviet energy priorities. Albina Tretyakova and Barry Kostinsky have chosen the transportation section, and in particular the dieselization of trucks, as a case study to illustrate how greater efficiency will be pursued as a supply alternative. In this overview, these various energy events will be placed in the context of the overall energy situation in the Soviet Union as well as noting commonalities with the United States in facing up to the limits of oil resource endowments.

The challenge to any country as vast and as well endowed as the Soviet Union is not to overcome deficiencies in energy resources but how best to manage what is there for the taking. One can assume that energy management in a centrally planned economy will hope to find the best combination of resources to be employed for specific purposes over time. The task is complicated by imperfect knowledge about the annual flow potential; the variation of the annual flow over time; the life expectancy of that flow; the accessibility of the resource; its relative cost to produce, transport, and consume; its physical suitability to various uses; its value as an export commodity; and how supply and user technology may evolve over time.

Most industrialized nations, including the Soviet Union, have typically relied upon fairly simple strategies and motives such as: use fuels which are costly to transport close to the point of production, move those that can be shipped cheaply to achieve national regional energy balances between supply and demand, and export salable energy that is in surplus either in the short or long term.

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But this tends to be a more difficult challenge to implement over time than it seems at first.

We find that over the past 40 years, and through a succession of Five Year plans, the Soviet Union has progressed from one version of this basic scheme to another. Several decades ago huge hydropower projects for electric power and coal for industrial steam raising and heat held the limelight for a long period. As the internal combustion engine became more important, petroleum was recognized as the fuel easiest to transport and to sell abroad. In contrast, natural gas and coal were comparatively difficult and costly to transport so tended to be dedicated to local uses. Nuclear power then appeared and was seized upon as likely to be superior to both hydro and coal in the longer term for producing electricity.

Basically the key elements in understanding the Soviet energy policy puzzle are as follows. One, the Soviet petroleum base, despite continuing arguments as to its exact size and state of depletion, should now be viewed as probably a physically constrained energy resource opportunity. After a century of exploitation it can no longer be relied upon to expand very much in the intermediate term even though it can be pushed modestly upward by heroic efforts in the short term. Two, while natural gas will ultimately have similar depletion problems it now appears to be the best energy opportunity for the Soviet Union for the intermediate term of a few decades duration. It should be able to be moved where it is needed to meet local supply deficiencies as well as to be exported for the acquisition of hard currency.

Three, turning to the non-petroleum energy forms, despite being a renewable or flow resource, hydro power encounters a ceiling on its annual potential as well as displaying a seasonal variation. However, improvements in long distance transmission can expand its interregional utility. Four, coal remains a vast resource despite being depletable in the long term. But it continues to be harassed by problems in technology and cost, low grade energy content, inferior quality, lack of ready accessibility of many reserves, expensive to transport, and frequently troublesome to use. Five, nuclear power is capital intensive to develop at a time when energy is already capturing a lion's share of national investment funds, it also has technical difficulties to overcome and is limited to generating electric power. Six, much of future Soviet energy supplies will be progressively located farther from current consuming centers. Seven, low cost, high voltage transmission for electric power over great distances would solve many difficulties but this is not yet firmly within the Soviet grasp. There is the alternative of building energy intensive industries near the energy sources but this is a further drain on scarce capital resources. Eight, the Soviet Union continues to need to rely on energy exports as a ready means for acquiring hard currency to be used in the purchase of key items only obtainable from outside of the Soviet Union.

This is an impressive set of parameters with which to cope, but it is not unique in this respect. They are remarkably similar in kind to those being faced, and sometimes ignored by the United States. In common with other industrial nations, both emerged from World War II as basically coal-iron-rail complexes with oil playing a specialized energy role as the most mobile of the fossil fuels. It

was also apparent that transforming raw energy into electric power was becoming increasingly favored in manufacturing, commerce, and residences. These trends were quite compatible with both the Soviet and United States' resource situations. Coal and iron ore remained in good supply and were accessible to the populations and industrial centers of European Soviet Union. The steady transition to a greater reliance on petroleum could also be accommodated first through the exploitation of the European and then later Western Siberian petroleum basins. The energy needs of the Center, Ural, and Northwest regions could be met largely by shipments of energy from the Transcaucasus, North Caucasus, and Volga regions. In addition, it became apparent that any surplus crude oil was a fungible commodity and could be readily marketed in the energy deficient Eastern bloc, or for hard currency from Western nations seeking oil supplies.

Crude oil, as well as its products, as a liquid possesses many natural advantages. Minimum effort is required to produce it, it can be moved by a variety of means between regions, it can be shipped readily across national boundaries or bodies of water, and combustion is easy and efficient. This has always made oil an ideal form of energy for the Soviet Union to cope with the maldistribution of its energy resources vis-a-vis its centers of consumption. Unfortunately, the steady reduction in any oil well's flow potential means that the status quo is hard to maintain. Nonetheless, it is also difficult not to continue to hope that another decade of supply can be coaxed out of known reservoirs and that depletion can be thwarted for at least a while longer.

As a consequence, we find that despite often stated concerns about the limits of Soviet crude oil supply, the history of Soviet energy policy continues to be characterized by attention to and investment in maintaining, or even expanding, production capability in its older fields as well as finding new ones. The former requires continuous expenditures with usually declining incremental returns. The latter requires its own separate set of investments with discoveries tending to be progressively smaller or farther from the points of consumption requiring additional investment in the means to move the oil or products. In the Soviet Union this has been further encumbered by trying to get along with aging facilities and a lack of significant technological progress comparable to other oil producers. Each planning cycle has revealed a recognition that this course of action is expensive, inefficient, and cannot endure. But to change direction is also costly and difficult to implement in the short term. The pressure for immediate results to avoid economic dislocations continues to color the decision process.

The four papers that follow provide a detailed examination of how the Soviet Union is dealing with its current concerns about oil and gas production in general, expanding the reliance upon the vast coal beds of the East, reassessing its electric power capacity situation given Chernobyl, and how conservation might be employed as an effective supply alternative. In each case, one can observe how these events once again are an extension of the historic Soviet behavior pattern.

The pessimistic analysis of Soviet oil supplies by the CIA a decade ago attracted wide attention and discussion only to see pro-

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duction continue to climb. It is perhaps kindest to view the CIA as having made a valid analysis but at the wrong point in time. Customary practice among oil producers is to conserve reservoir energies to achieve maximum ultimate recovery and to distribute that recovery over time in a way that will achieve economic efficiency. But it is quite possible to ignore this and to accelerate production per well at the expense of reservoir energy while lowering total recovery over the life of the wells, or to drill more wells to permit the production curve to be moved upward and forward in time, i.e., seek a higher peak now with a sharper decline later but with no loss in ultimate recovery, or to do both. If the Soviet industry was behaving in this fashion, then the CIA misjudged not so much the Soviet resource position but rather what they were willing to sacrifice in the longer term to meet immediate needs. Stern notes that while Soviet petroleum technology has lagged it should not be viewed as so primitive that it could not increase production if that was the primary goal.

Stern suggests that once again the Soviets are willing to continue to push for oil production, if not to raise production to at least keep it "high and stable". While appropriately warning that the full payoff from past investments will only be observable over several years, the response of a 3.4 percent increase in production between 1986 and 1985 (slightly below the peak year of 1983) for a 31 percent increase in oil industry investment may be indicative of the progressive difficulty in getting rewards from effort. In the United States this lesson was obvious when a 3.5 fold increase in price from 1978 to 1982 spurred a doubling of total wells drilled only to see production decline by 0.7 percent. The peak production of 1970 was not even approached. While one should recognize that the vast land mass of the Soviet Union has not been drilled as intensively as the United States, its opportunities for large discoveries are in frontier and hazardous areas. If the Soviet Union chooses to stabilize oil production that may not necessarily be achievable with a stable level of investment.

The Soviet Union is now tending to gravitate toward natural gas, an alternative which some feel should also be pursued more vigorously in United States. This strategy has been reinforced by the successes achieved in recent years. Production targets have not only been met but exceeded, and the same has held for pipeline construction timetables. All of this has been possible because of production from six large fields in North Western Siberia. Soviet developed reserves now amount to 40 percent of the world's stock. But this has not been totally free of difficulty. Pushing for production instead of orderly field development is once again a problem. And there is concern about the commitment for the parallel development of infrastructure to make continuity of operations in isolated locations feasible. The pipeline expansion has been made possible due to access to imported large diameter pipe as well as a willingness to rely upon a minimum number of compresssor stations shortchanging back-up capacity. Nonetheless, there now is considerable confidence that gas production will increase until at least the mid-1990s and could be held at this high level for some unknown period thereafter.

The question always emerges, once the limited, depletable petroleum resources begin to fail—perhaps a decade or so from now—what then? Coal in this respect usually appears in the role of the temptress—always so promising—but those who succumb to its promise usually regret it. There are also the renewables waiting to be called upon, but they tend to be diffuse forms of energy and frequently lack demonstrated technologies. So they do not seem to draw the same amount of attention as coal or nuclear fuel. Coal, once the energy foundation of industrialization, appears as though it could re-emerge as a major source of energy. For the Soviet Union to follow this course would entail a number of difficulties. First, the Soviet Union has always relied primarily upon underground mining in its Western coal beds. But underground mining, even at its best, cannot match surface mining in productivity, something the Soviet Union needs urgently. To compound the problem, the Soviet performance underground has not been that impressive in any case.

Soviet attention has now turned away from costly outlays in trying to innovate and improve underground operations toward an increase in surface mining. This has resulted in moving from 25 percent surface mining in 1970 to 40 percent in 1985. (For comparison, the United States industry to improve its productivity and competitiveness increased surface mining from 30 percent twenty years ago to over 60 percent today). The first moves were to open new surface mines that were not too large and only a short haul from existing, small electric power plants. But more recently, the plan has shifted toward opening large mines in a few selected basins. The goal is one billion tons by the year 2000. The performance between 1987–1992 will be a trial period to determine if this can be accomplished.

It will be necessary to find responses to a number of things, e.g., the low quality of the coal being mined and how to transport the as-mined energy thousands of kilometers. Among the possibilities are: new mining technologies, mine mouth power plants, synfuel production, coal slurry pipelines, and ultra-high-voltage transmision. But each of these will place another heavy burden on managers who have never dealt with either these technologies or the complex systems using them. Technology and development are already behind schedule. The low quality of the coal is a serious handicap. Much of the coal to be mined is 3,500 kcal/kg (6300 Btu/lb) or less. This is comparable to the lignite B found in the Dakotas, the lowest quality of coal used in the United States.

Coal slurry pipelines would be an attractive solution to the problem of moving coal to distant power plants. The United States has moved coal considerable distances in this fashion for over a quarter of a century. Power plants have no problem in using a coal/water mix. But the Soviet Union has only experience in two lines moving coal 10 and 15 kilometers. In addition, because of the low heat content of the coal being shipped, the Soviet Union will attempt to compensate by shipping a 70 percent coal/water slurry. This has not been used commercially in power plants before.

Another approach would be to employ the coal in synfuels production. The Warner-Kaiser paper reveals that while the Soviets are interested in liquefaction current oil prices have shifted atten-

tion toward heat treatment (pyrolysis) instead. This will remove moisture and produce a high heat content "semi-coke". But this product is difficult to ship, to store, and to use. For the moment, the ability to manufacture liquids will remain in doubt both technically and with respect to cost. Finally, there is the high voltage transmission of electricity from mine mouth plants. This, too, is untested. So coal once again seems to remain an uncertain or at best long term solution. This leaves natural gas and perhaps nuclear power as the "now" answers for relieving the burden on oil.

We can find another common thread in the fabric of their energy systems for the Soviet Union and the United States to unravel. Electricity is an attractive form for delivery to the end consumer for many uses. Only in the transportation sector is it limited in its applications. This, of course, has made nuclear power development attractive to the Soviet Union. While oil and gas would continue to be shipped great distances as well as exported, nuclear plants coupled with coal and hydro could give the Soviet Union greater overall capacity as well as system diversity in their electric power sector.

Thornton reveals that here too there are challenges to be faced. Development of capacity is lagging to a point where fears have surfaced about possible constraints on industrial development. As noted above, long distance, high voltage transmission is proving difficult to accomplish. Moreover, the coal being used with its high moisture and low heat content presents operating problems for the power plants. Added to this, Chernobyl has undermined confidence in nuclear power as a parallel development of new capacity. Given the reluctance to commit fully to a mjaor reliance on Eastern coal-based power plants, a redesigning and slowing down in nuclear power plant development could not come at a more inopportune time. Oil and gas are already absorbing major amounts of capital. To now slow nuclear power expansion as well as to direct additional funds into alterations in the system is most unwelcome.

The Soviet electric power system is characterized by large plants which are able to operate at low heat input rates and to achieve high load factors compared to the averages attained in other countries. But this achievement is gained at the expense of some loss in system flexibility. Incremental growth in capacity has been strong but the capital costs have been moving upward due to: (1) the greater emphasis on nuclear; (2) actual increases in unit building costs; and (3) greater overhead charges. Furthermore, actual construction costs tend to exceed the pre-construction estimates because project planners tend to be optimistic about the kinds of facilities in which they have a personal interest.

There has been effort in the past to shift power production toward oil and gas and away from coal in conventional steam power plants. This eventually proved to be an inopportune choice when oil and gas prices rose, enhancing the value of oil and gas as export commodities. This provided another justification for moving more toward nuclear power. Nonetheless, oil consumption by power plants continued to increase from 1975 to 1985. Some of this was a reflection on the Soviet's inability to upgrade as much crude oil or residual into lighter products as might be desirable.

Attention is now turning to providing for greater peaking capacity. This eases the burden on the demand for equipment to be installed in new base load plants. In constructing peaking capacity it is possible to use equipment obtained from the West. This is a more attractive alternative today because the oil and gas used for peaking power output is available at a lower cost than previously. Thornton paints a picture of steady expansion in electric power capacity, with hydro steady, thermal losing ground, and nuclear growing in percentage terms. But despite this, if energy demand growth remains as intensive as it has been, the rate of growth in power output will not be sufficient to support the economic targets being considered.

This leads to the final paper by Tretyakova and Kostinsky which serves to illuminate some facets of a new and growing component in Soviet energy planning. Once again a parallel with the United States can be detected. Both countries have relied upon vast initial endowments of fossil energy to provide a means to expand their economies and to increase their productivity. Back in 1970 in the United States, energy was a solution not a problem. Energy could provide both low cost comfort and convenience for the individual, energy could conquer distances in order to serve a geographically dispersed population, energy-using machines increased worker productivity, and energy could compensate for declining quality of other resources so that the U.S. competitive position did not deteriorate. In contrast, during the last 15 years the United States public became energy conscious, energy became the focus of industry cost-cutting, and government became worried about energy security as well as the impact of energy prices and imports on economic growth. It should be noted that this last item is primarily an oil problem and not one of energy in general.

The Soviet Union also needs to find a way over time to alter the basic mix of the energy sources relied upon. In addition, it must now begin to capitalize on the fact that conservation can become, in effect, a supply alternative. To the extent that the Soviet Union wishes to reduce the burden on its oil resources and production facilities and to lower the capital flowing to that industry, substitution of one energy form for another will certainly be welcomed. Natural gas now seems to be destined to do that in the immediate future. But natural gas cannot do it alone. So the Soviet Union would like between now and 1990 to meet half of its incremental need for energy by reducing energy demand through conservation rather than supplying it with additional new primary fuel.

Energy consumed per unit of Soviet national income has historically declined as national efficiency has improved. But more savings are now expected, and transportation will receive major attention. Transport consumed 13 percent of domestic supplies in 1980 and has been trending slowly downward for several decades. Major contributors to this have been better energy technology, modernization of the railroads and a shift away from coal to the more efficient combustion of oil and gas. However, some of these trends have now largely run their course. For the immediate future the Soviet Union has as its three most attractive prospects for reducing the demand on fossil fuels: nuclear power expansion, upgrading of equipment so that it will be more energy efficient, and new efforts

in transportation. The first of these choices, as previously discussed, places a burden on capital requirements. Upgrading and retrofitting of energy consuming plants also carries with it a capital burden and demands for scarce equipment. Progressively changing the transportation stock may also have some problems in this respect, but more importantly it raises the question of how much leverage there is in a sector that only consumes 13 percent of the Soviet energy flow per year.

Nonetheless, a major target of the Soviet conservation program will be to switch its trucking fleet from gasoline to diesel fuel. This is not likely to prove to be as rewarding an exercise in conservation as was the doubling of the miles per gallon performance of the U.S. passenger car fleet. But whatever the Soviet savings they will be in that key commodity—oil. It is interesting to note that air transport, where the United States has made major gains, is not a target for improvement efforts.

The Soviet Union can set planning goals for the energy efficiency of new equipment and have targets for energy users, but there is still the question of the ability to achieve those goals. In the United States much of the motivation stemmed from a five-fold increase in the real price of crude oil and a commensurate increase in petroleum product prices at the point of consumption. As a consequence, energy consumption stopped climbing and the energy use per dollar of GDP moved down more rapidly. The Soviet Union, where energy inefficiency has also been tolerated for a long time, must now find its own particular way to activate conservation as a major contributor to its future energy policy.

A final facet of the Soviet energy scene is the energy export market. The Stern paper questions whether this should continue to be viewed as simply the disposal of the oil remaining after domestic needs have been met and deliveries to the Eastern bloc countries have been made. Or have import earnings now become a target of importance in their own right and are integrated into the total Soviet energy strategy? Those who have presumed the former in the past have tended to be poor predictors. While the export decisions of the Soviet Union seem to be more than merely a casual disposal of whatever surplus happens to appear, it may be equally unwise to exaggerate the importance of import earnings in the total scheme of things.

The Soviet Union is a price taker in world oil markets because it does not have the export volume to be a price maker. In addition, the Soviet bureaucracy tends to react slowly to price changes. Nonetheless, it is certainly interested in maximizing its hard currency earnings as best it can within the limits established by the flow of oil from its wells, storage capacity available, and the terms of the contracts into which it has entered. This means managing deliveries in the short term so as to hold oil off of the market temporarily when prices are low and expected to improve shortly. Following such practices does not mean that the Soviets are as concerned about world oil prices as many Western importers are inclined to be. Neither does it suggest that the Soviet Union should be viewed as being insulated from the world price situation. As an example, whether or not to develop costly Siberian oil resources is surely influenced by what kind of assumptions are being made as

to whether or not world oil prices will stay low for an extended period of time.

It is also useful to remain aware of the relative magnitude of the currency earnings from the export of Soviet oil and gas when viewed in the context of the total Soviet economy. When this is done, it becomes apparent that a lowering of those earnings would not be welcomed but represents a tractable problem. The Soviet Union could temporarily increase borrowing, do some selective reduction of imports, look more to other exportable commodities or products such as gold, draw down their Western accounts, or divert Eastern bloc shipments to the West, and in this fashion ride out low price periods.

In the first quarter of 1987, the level of Soviet exports was below expectations and viewed by some as a possible arrangement with the Saudis to help stabilize the somewhat higher price. This may be true, but it could also be merely a reflection of a typical Soviet move to keep revenues as constant as possible—sell more to compensate for a lower price and sell less when the price is high. In this respect, second quarter activity will be of interest. There may be from time to time expressions of concern in the Soviet Union about problems in oil production. But these may not necessarily coincide or even presage an actual drop in production—it may even increase.

To reiterate, neither the Soviet Union nor the United States have an absolute problem in their energy supply potential. But they both face difficulties with respect to oil and how to make an evolutionary shift in their reliance on the various sources of energy that are physically available but are also both deliverable and economic. However, a willingness and the means to accomplish this task effectively seem to evade both countries. In the last volume of papers concerning the Soviet Union prepared for the Joint Economic Committee, one author expressed a view that the Soviet Union would wait and watch the Persian gulf turmoil and from among its various options would most likely choose to encourage and exploit any instability. Today a different view might be gaining some credibility. This would be that the Soviet Union with respect to oil and its near term hopes for natural gas might now see its best interests served by period of stability in the Middle East accompanied by a moderate price level for oil that could be depended upon to hold within limited swings. It would more than likely be joined by the United States in this desire.

SOVIET OIL AND GAS PRODUCTION AND EXPORTS TO THE WEST: A FRAMEWORK FOR ANALYSIS AND FORECASTING

By Jonathan P. Stern [1]

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SUMMARY

The spring of 1987 marks an important anniversary for Soviet energy watchers: it is ten years since the famous CIA reports on Soviet oil appeared. The reason for mentioning this is that even those who know nothing else about Soviet energy, recall the famous forecast of a strong and imminent need for the CMEA [2] countries to import large volumes of oil from world markets by 1985, at a time when there seemed no way that such imports could be accommodated without further massive rises in world oil prices, or active Soviet military intervention in the Middle East.

Reflecting on a decade of western forecasts of Soviet energy—but specifically oil and gas—development, the striking feature is their failure to reach conclusions of even remotely approximately accuracy in the area which was of genuine interest to the public: Soviet oil exports to OECD countries. Over the past decade, the USSR became a major actor in world oil markets contrary to almost all western expectations.[3] Soviet gas exports to Western Europe also expanded faster than was thought likely in the late 1970's.

[1] The author is Head of the Joint Energy Programme at the Royal Institute of International Affairs in London. Much of this article is drawn from his study of: *Soviet Oil and Gas Exports to the West: Commercial Transaction or Security Threat?* Brookfield, Vt: Gower Publishing Company, 1987.

[2] CMEA countires refer to the USSR and the East European countries of the council for Mutual Economic Assistance: Bulgaria, Poland, Hungary, Czechoslovakia, Romania and the German Democratic Republic.

[3] This was due both to an increase in the volume of Soviet exports and a sharp decline in the amount of oil in world trade.

This chapter reviews developments in Soviet oil and gas production and exports (to the West) over the past decade, and suggests the elements of a framework which are needed to make judgements on future trends. Finally, some tentative projections of the period up to 2000 are offered.

Oil Production

The Soviet long term energy programme, covering the period 1980–2000, states that the aim is to raise the level of oil production throughout the period, although equal prominence is given to the aim of ensuring a "high and stable" level of oil output, certainly up to 1990.[4] In the mid 1980's, oil production difficulties were giving the planners considerable cause for concern, the focus being in Western Siberia which in 1986 produced 64 percent of Soviet oil.[5] In 1985, the decline in production seemed to accelerate and during his visit to the major Siberian oil and gas production locations in September of that year, General Secretary Gorbachev spelled out a number of negative trends which had become increasingly evident over the past decade.[6] Most important among these were: overproduction, (particularly at the supergiant Samotlor oilfield) which had led to reduced recovery factors; persistent failure to build a Siberian economic and social infrastructure (including acceptable living accommodation); a lack of overall management of Siberian operations including all aspects of production and transportation of fuels and construction materials in support of those functions. None of these criticisms came as a great surprise to Soviet energy watchers, but the fact that the new General Secretary had travelled to Siberia to make such a frank speech directly to workers (which was subsequently published), gave an indication of the urgency of the message.

As far as oil reserves are concerned, estimates of which have been a state secret since World War II, Gorbachev revealed that over the past decade, the rate of proving up reserves to replace current production in Western Siberia had fallen to the average level of the industry elsewhere in the country.[7] The difficulty in achieving production increases in Siberia in the short term was underlined by a number of highly critical articles in the press, at the beginning of 1986, which spelt out in more detail the problems of the industry, including the projection that production at the giant Samotlor oil field would fall by one quarter in the period 1986–90.[8]

The industry appears to be dealing with an insufficiency of *proven* reserves, rather than a problem with the totality of the oil resource base. Smaller fields, geographically dispersed over a wide area in Western Siberia, mean that development becomes more

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[4] The Long Term Energy Programme is described in: "Osnovni Polozhenie Energeticheskoi Programmi SSSR na Dlitel'nuyu Perspectivu," *Ekonomicheskaya Gazeta*, No. 12, 1984, pp. 11–14.

[5] Theodore Shabad's annual roundup of regional Soviet fuel production figures can be found in the April issue of *Soviet Geography: Review and Translation*. The April 1986 issue contains details of the peaking and decline at the Samotlor field and other West Siberian deposits.

[6] "Prebyvanie M.S. Gorbacheva na Tyumenskoy Zemle," *Ekonomicheskaya Gazeta*, No. 37, September 1985, pp. 2–4.

[7] Some commentators interpreted Gorbachev as saying that proven reserves in Western Siberia have been reduced to the average level in the rest of the country. My reading of his text is more ambiguous and less drastic.

[8] V. Kuzmishchev *et al.*, "Trevogi i Nadezhdy Samotlora," *Izvestiya*, January 28, 1986.

complicated and harder to co-ordinate, and hence increasingly expensive. The industry therefore has to prove up reserves faster and concentrate on exploratory drilling, as well as keeping up with development drilling. Exploratory drilling in Western Siberia is to double in the present five year plan period. At the same time, the number of oil fields in production is to be raised by nearly 50% and a major effort is to be concentrated on well servicing and repairs.[9]

The top level shake up of officials which took place at the beginning of 1985—including the replacement of the Minister—indicates that the leadership is hoping that the problem can, at least in part, be attributed to organisational failings and poor management of the industry. There has been considerable "scapegoating" of officials in Siberia—along with perfectly genuine accusations of incompetence, particularly as regards the use of expensive imported equipment—and a refusal to recognise that much of the damage was caused by Moscow planners who raised Siberian production targets remorselessly in the 1970's in pursuit of short-term gains.[10]

In the view of this author, the best way to look at future Soviet oil production levels is to try to estimate an optimum target, taking into consideration the investments involved in exploring for and producing incremental oil in Siberia. If, as the leadership insists, the industry can operate more efficiently by better organisation of labour and better utilisation of the plant and equipment which are already in place, then this is surely a preferable course of action to additional massive investments. The observation that in 1986 the planned increase in oil industry investment was 31% while actual production increased by only 3.4% to 615mt, is somewhat misleading.[11] Investment in one year is not immediately reflected in increased production. Yet the orders of magnitude involved in returns on capital investment are clear.[12]

The most important question is the volume of investment which is needed to support a given level of production. From the Soviet point of view it would seem sensible to try to stabilise oil production at a level where investments remain stable, as long as that level of production is sufficient to support the country's minimum liquid fuel requirements.[13] In this regard the 1987 target of 617 mt—virtually the same as the 1986 target and only marginally greater than 1986 production—may be significant.

The tradeoff between raising investment in order to maintain stable (or at the very best slowly rising) production of around 600–630mt per year, and decreasing production at a stable (or at least only slowly rising) investment level must be addressed without

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[9] Patrick Cockburn, "Moscow to boost deep oil drilling by 40%," *Financial Times*, May 29, 1985; Patrick Cockburn, "Soviet oil output declines," *ibid.*, January 20, 1986; David Wilson, "Serious implications in oil shortfall in USSR," *Petroleum Review*, January 1986, pp. 18–19.

[10] Patrick Cockburn, "Soviet oil province managers sacked," *Financial Times*, April 29, 1985; for an account of mismanagement of the gaslift programme at Samotlor, see V. Borodin, "Reservy Neftynovo Plasta," *Sostialisticheskaya Industriya*, February 3, 1985.

[11] *Ekonomicheskaya Gazeta*, No. 48, November 1985, p. 5; 615 million tons (mt) of oil is approximately equivalent to 12.3 million barrels of oil per day.

[12] For details on this subject see: Albina Tretyakova and Meredith Heinemeier, *Cost Estimates for the Soviet Oil Industry: 1970 to 1990*, Center for International Research, US Bureau of the Census, Washington DC: June 1986, CIR Staff Paper No. 20, especially Table 16, pp. 51–2.

[13] This is not a new or revolutionary thought, see: Ed. A. Hewett, *Energy Economics and Foreign Policy in the Soviet Union*, Washington D.C.: Brookings, 1984, p.47.

delay. It is here that the issue of exports to both allies and world markets begins to loom large.

Natural Gas Production

As far as the natural gas industry is concerned, the 1980's have already been an extraordinarily successful decade. In the first half of the decade, production targets have been overfulfilled every year by meeting a most ambitious schedule of trunk pipeline construction; a task which virtually every western commentary concluded was unrealistic. During the period 1981–6 the industry delivered nearly 60 BCM of gas over target (Table 1).[14] The six major gas pipelines from the Urengoy deposit to the west of the country, including the famous pipeline to Western Europe, were built ahead of schedule, and this enabled nearly 60% of the country's gas production to be delivered from Siberia in 1985. Unlike the Siberian oil industry, which has discovered only one 'supergiant' field (Samotlor), the natural gas resource base is secured by at least six large fields within a comparatively small geographical area in North Western Siberia.[15] With roughly 40% of the world's proven gas reserves, this sector of the Soviet energy balance has an outstanding future.

TABLE 1.—SOVIET OIL AND NATURAL GAS PRODUCTION: PLANNED AND ACTUAL 1976–90

[Oil in million tons, gas in billion cubic metres]

	Crude oil		Natural gas	
	Planned	Actual	Planned	Actual
1976	520.0	519.7	313	321.0
1977	550.0	545.8	342	346.0
1978	575.0	571.5	370	372.2
1979	585.0	585.6	401	406.6
1980	606.0	603.2	435	435.2
1981	610.1	608.8	458	465.0
1982	614.0	612.6	492	500.7
1983	619.0	616.3	529	535.7
1984	624.0	612.7	578	587.4
1985	628.0	595.0	632	643.0
1986	616.7	615.0	672	686.0
1987	617.0	.....	712	.....
1990	625–640	.....	835–850	.....

All plan targets are annual plans, except for 1990 figures which are 5-year plan targets.

Source: Jonathan P. Stern, "Soviet Oil and Gas Exports to the West: Commercial Transaction or Security Threat?," Brookfield, Vt: Gower Publishing Company, 1987, Table 1, p 83.

However, the remarkable achievements of the past decade should not conceal the difficulties which lie ahead. On his September 1985 Siberian trip General Secretary Gorbachev was outspoken about the need for the gas industry to learn from the lessons of the oil industry.[16] The implication was that the same mistakes were indeed being made, which if allowed to continue would lead to the same results. The Siberian gas fields are so large that the industry's incremental production over a five-year period can be ac-

[14] 1 billion cubic metres (BCM) = 100 million cubic feet of gas per day or 0.89 mt of oil.
[15] The fields are: Urengoy, Yamburg, Medvezhe, Zapolyarnoe, Bovanenko, and Kharasevey.
[16] As note 6.

counted for by just one field. In the 1981–85 plan, this field was Urengoy, in the 1986–90 plan it will be Yamburg. However, as in the case of the oil industry, Gorbachev highlighted the shortcomings of the Siberian gas development drive with respect to Urengoy, where the rapid production gains had been made at the expense of development drilling. More productive areas of the field have been drilled in the early stages of development instead of planning an optimum strategy for the whole field in order to yield maximum recovery rates. In addition, Gorbachev stressed the lack of infrastructure for both production and social needs as a problem that would have negative effects in the industry. This has always been a chronic problem for the Siberian gas industry because of its more remote location in comparison to the oil deposits.

After Gorbachev's speech, the press revealed further shortcomings in gas industry performance. As mentioned above, the transmission problem, which has dogged the industry since its inception, appears to have been largely solved as far as laying and welding large diameter pipeline under Arctic conditions is concerned. However, there is still a considerable requirement for imports of large diameter steel pipe. In addition, there are still some problems with compressor stations, both in the area of manufacturing 25 Mw units domestically, and installing these on lines to keep up with the pipeline crews. The industry got around this problem in the first part of the 1980's by "economising" on compressors, i.e. installing less than the required back-up capacity at the stations.[17] While this has allowed gas to flow in the lines, it can present problems if breakdowns occur, because there is insufficient reserve capacity. Nevertheless, Soviet determination to push ahead with their domestic programme of compressor station construction is demonstrated by the fact that the Yamburg to Eastern Europe Progress pipeline, due to start operating in the late 1980's, is being constructed entirely with Soviet and Czech turbine units.

The challenge of producing gas from the Siberian fields is immense. Yamburg, which, on a large-scale map, appears only marginally further north than Urengoy on the Taz Peninsula, lies north of the Arctic Circle and presents much more severe problems of terrain.[18] The entire labour force will be flown in from the Urengoy infrastructural base and there will be no permanent accommodation. If it is true that the planners intend incremental gas production in the 1991–96 Five Year Plan to come from the Bovanenko and Kharasevey fields (and also from the smaller Kruzenshtern deposit between these two immense fields) situated between the 68th and 72nd parallels, the challenges for the industry will increase enormously as the climatic conditions become even more difficult and transmission lines become even longer. The extent to which the Yamburg development meets its production targets will

[17] "A Dolg Rastyot," *Izvestiya*, January 8, 1986.

[18] There is geographical confusion about the location of Soviet gas deposits. Urengoy and Yamburg are located on the Taz Peninsula, east of the Gulf of the Ob. The next cluster of larger fields to be developed, including Bovanenko and Kharasevey, are located on the Yamal Peninsula, west of the Ob Gulf but much further north where conditions are even more difficult. Western and Soviet sources confuse the situation by referring to the whole region as the Yamal Peninsula or just "Yamal".

be a pointer to the readiness of the industry to move further north to the deposits of the Yamal Peninsula.[19]

It must be a matter of some admiration that, despite infrastructural shortcomings and delays which are to be expected when operating in such a remote and harsh environment, the gas industry continues to exceed the expectations of Soviet planners by wide margins.[20] The long term energy programme suggested that gas would be used to bridge the gap between the present, and a future era of nuclear power and open-cast lower calorific value coal. Gas production will reach its maximum level in the mid 1990's and stabilise thereafter. The major constraint, particularly in the short to medium term, is likely to be the capacity of the Soviet domestic economy and export markets in Eastern and Western Europe to absorb these quantities of gas.[21]

Soviet Oil and Gas Exports to OECD Countries

Crude Oil and Oil Products

Soviet crude oil and products exports to OECD countries grew steadily throughout the 1960's and 1970's, but in the late 1970's the totals stabilised at just under 60 mt partly, it was hypothesised, because of the leveling off of Soviet oil production and partly because of the windfall foreign-exchange gains of the 1978/9 oil price rise. As Table 2 shows, oil exports fell in 1981, but the following 3 years showed a sharp and sustained increase which took exports to more than 81 mt in 1984, before falling sharply to 67.5 mt in the following year and rebounding to around 75 mt in 1986.[22] Viewed in the context of the previous 25 years, the increases of the 1981–84 period were extremely surprising at a time when oil production was stagnating.

TABLE 2.—SOVIET CRUDE OIL AND PRODUCTS EXPORTS TO OECD COUNTRIES, 1977–85

[Thousand tons]

	1977	1978	1979	1980	1981	1982	1983	1984	1985
OECD	34,952	36,691	36,780	33,418	29,395	36,777	44,635	49,628	37,735
	22,036	26,904	22,019	23,584	24,124	32,189	33,304	31,814	29,747
Total	56,988	63,195	58,889	57,002	53,519	68,966	77,939	81,442	67,482
United States	160	38					2		42
	527	406	62	34	275	32	34	656	321
Japan	72	59	43	91	95	40	102	76	134
	521	497	604	437	503	580	769	776	751
OECD Europe	34,720	36,593	36,827	33,327	29,300	36,737	44,531	49,552	37,559
	20,988	26,099	21,353	23,113	23,346	31,577	32,501	30,340	28,675

First line gives crude oil, NGLS and refinery feedstocks.
Second line gives oil products.

Source: International Energy Agency, "Quarterly Oil Statistics," (various years), Paris: OECD.

[19] The investment cost associated with moving into these regions is also important. Albina Tretyakova and Meredith Heinemeier, *Cost Estimates for the Soviet Gas Industry: 1970 to 1990*, Center for International Research, US Bureau of the Census, Washington DC: June 1986, CIR Staff Paper No. 19.

[20] This pattern continued in 1986 with the industry delivering 14 BCM over target. (Table 1)

[21] See for example: Matthew J. Sagers, "How has the Soviet economy absorbed all that gas?" *PlanEcon Report*, Vol III, January 14, 1987, Number 2.

[22] The Soviet Foreign Trade Statistical Yearbook ceased publishing energy export statistics in volume terms in 1976, and only publishes rouble figures. The figures presented here are taken from the International Energy Agency (OECD) publication, *Quarterly Oil and Gas Statistics*.

A major difficulty in estimating Soviet oil exports to OECD countries involves the treatment of crude oil exported from Middle East countries on Soviet account, usually in payment for Soviet deliveries of military equipment and industrial goods. Reliable data on volumes, origins and destinations of "third country" crude oil exported on Soviet account are very difficult to obtain. This source became important in the 1980's when volumes rose from around 3–4 mt in 1980 and 1981 to around 13–14 mt per annum in the period 1983–85.[23] If all of this crude oil had been transferred directly to world markets, more than one third of the increase in Soviet oil and products exports to OECD countries, in the period 1981–84 would be directly attributable to third-country exports.

Relations with OPEC

A factor with a *possible* bearing on Soviet oil export policy concerns relations with OPEC, which have become an important part of Soviet Middle East diplomacy in the 1980's. In the early part of 1983, with the Soviets moving considerably increased volumes of crude oil (including some from Middle East countries) and products to world markets, an Algerian emissary from OPEC was sent to Moscow to try to gain some informal understanding about volumes and prices.[24] The next important event occurred in 1986 as world oil prices began to fall rapidly, when a senior official of the Soviet Academy of Sciences made a speech in Vienna in which he was widely quoted as saying that, if oil prices continued to fall, it was likely that the USSR would cut the rate of growth of its oil production and that, at low prices, oil might actually be purchased from the world market.[25] This statement was remarkable, not for any insight which it provided into Soviet oil policy, but in that it could be seen as the first wholehearted Soviet endorsement of OPEC attempts to support oil prices. By the autumn of 1986, the Soviets had made a promise of tangible cooperation, announcing an intention to cut exports by 100,000 barrels per day for the months of September and October.[26] In January 1987, at a meeting in Moscow with the Saudi Oil Minister, it was announced that the USSR would cut oil exports by 7%.[27]

It remains to be seen whether such statements simply follow a longer term trend of political gestures in support of OPEC initiatives to curtail export volumes and raise prices (and an important manifestation of intelligent Soviet diplomacy in the Middle East region), or whether they are a genuine expression of Soviet oil

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[23] Preliminary reports indicate a surge in these deliveries to more than 21 mt in 1986. *Plan Econ Report*, Vol. III, No. 3 p. 2. The USSR was importing around 13 mt of Middle East crude in the early 1970s before the first major oil price rise. Thereafter, in the 1970s, imports averaged 6–8 mt falling to record low figures in 1980 and 1981, just after the second oil price rise. *Ibid*, Vol. I, Nos. 17 and 18, December 30, 1985, Table 4, p. 15; *Ibid*, Vol. II, No. 27, July 3, 1986. These figures only relate to Middle East crude oil re-exports. They do not include deliveries of Venezuelan crude to Soviet allies (Cuba and Nicaragua) in Central America.

[24] "OPEC to ask Soviets to help prop prices," *International Herald Tribune*, April 23, 1983.

[25] Patrick Blum, "Moscow may restrain oil output," *Financial Times*, March 6, 1986.

[26] John Hooper, "Soviets agree to cut oil exports," *Guardian*, August 21, 1986. Max Wilkinson, 'Calm reaction to Soviet oil export cuts', *Financial Times*, August 23, 1986.

[27] Bll Keller, "Soviet Cuts oil exports, saying it backs OPEC," *New York Times*, January 23, 1987.

export policy. The quantities involved and the timing of Soviet statements—particularly for the first quarter of the year when Soviet exports are always about one third lower than normal—will make any action difficult to verify. Even if a cut in Soviet oil exports is verified during a particular period, it may say more about Soviet ability or willingness to export oil at much lower prices than about solidarity with OPEC policies.

NATURAL GAS

The history of Soviet gas exports to the West is much shorter than that of oil, less than two decades having elapsed since the first deliveries of Soviet gas to Western Europe. Exports began in the late 1960's—Austria (1968)—and accelerated at the beginning of the following decade -Federal Republic of Germany (1973), Italy and Finland (1974). It is easy to forget that until 1974 the USSR was a net *importer* of natural gas as a result of the deliveries which it received from Iran and Afghanistan and which were consumed in the south west of the country, a growing natural gas deficit region due to the rapid shift of production to the eastern regions beyond the Urals.

The late 1970's saw two major developments in Soviet gas export policy: first, the emphasis on the USSR as an exporter, rather than as a transit country for Middle East (specifically Iranian) gas to reach Europe. Secondly the recognition that, despite initial promise, the major Soviet mode of export was to be pipeline rather than LNG and that the major market for natural gas in Western Europe.[28] These developments must be put alongside fulfilment and overfulfilment of plan targets—a feat never achieved during the previous 25 years—and the discovery and establishment of a resource base which was staggering by any calculation and secured the future of the industry over the next several decades. Thus during the late 1970's the USSR established itself as a gas exporter of significant proportions and gave notice that it would become a major force in European gas trade.

At the beginning of 1980, it was announced that West European utilities were negotiating with Soyuzgazexport for supplies of up to 40 BCM per year. The events of the following three years, surrounding the "pipeline episode", received tremendous publicity and have been extensively written up.[29] In the event, contractual volumes were smaller than had originally been foreseen—largely due to a weakening of current and projected gas and energy demand as a result of the general economic recession in Western Europe. For

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[28] The 'North Star' and Yakutia LNG projects are now largely of interest to historians of natural gas trade and details can be found in Jonathan P. Stern, *Soviet Natural Gas Development to 1990*, (Lexington Mass: D. C. Heath/Gower, 1980.) There is a very interesting Soviet analysis of these projects in I. S. Bagramian and A. F. Shakai, *Kontrakt Veka (Contract of the Century)*, Moscow: Polititizdat, 1984. Only the small Sakhalin LNG project remains from the LNG era, see: Peter Egyed, *Western Participation in the Development of Siberian Energy Resources: Case Studies*, Research Report No. 22, East-West Commercial Relations Series, Institute of Soviet and East European Studies, Carleton University, Ottawa, 1983; and Jonathan P. Stern, *Natural Gas Trade in North America and Asia*, Aldershot, Gower, 1985, pp. 198–201.

[29] Jonathan P. Stern, 'Specters and Pipedreams', *Foreign Policy*, No. 48, Fall 1982, pp. 21–36; Jeremy Russell, *Geopolitics of Natural Gas*, Cambridge, Mass: Ballinger, 1983; Angela E. Stent, *Soviet Energy and Western Europe*, The Washington Papers No. 90, Washington, D.C.: Georgetown Centre for Strategic and International Studies and Praeger, 1982; Bruce W. Jentleson, *Pipeline Politics*, Ithaca: Cornell University Press, 1986.

the same reasons, there was a slight fall in Soviet gas exports to Western Europe in the early 1980's; the upward trend being resumed only in 1984. (Table 3) Projected average yearly volume sales, through the famous pipeline, of less than 30 BCM would leave some spare capacity in the transmission system which has been constructed.[30]

TABLE 3.—SOVIET NATURAL GAS EXPORTS TO THE WEST, 1970–95 (BCM)

	1970	1975	1980	1982	1983	1984	1985	Early 1990's	
								ACQ*	Possible range
Austria	1.0	1.9	2.9	2.9	2.4	4.0	4.2	3.9	3.4–4.4
Federal Republic of Germany (including West Berlin)		3.1	10.7	9.7	9.9	12.4	12.4	19.35	16–25
Italy		2.3	7.0	8.6	7.7	7.5	6.0	12.25	10–15
France		—	4.0	3.8	3.6	4.5	6.8	8.0	6–12
Finland		.7	.9	.7	.7	.8	1.0	1.2	1–2.5
Switzerland		—	—	—				0.36	0.36
Turkey								**3	1–6
Greece								—	0–4
Total	1.0	8.0	25.5	25.7	24.3	29.2	30.4	48.06	36–69

* Annual average contract quantity.
** Take or pay commitments in the Turkish contract are uncertain.

Source: As table 1, p. 121.

In the early 1980s, the West European gas business became a buyer's market, with exporters competing for shares of a total European demand which looks as if it will expand rather slowly at least in the short to medium term. The USSR, therefore has had to adjust to a situation which, until 1980, had looked entirely different. In the *short term*—up to 1990—while this situation prevails, Soviet efforts to sell gas will consist of a three major elements:

(a) To press ahead with long-term, firm contract sales of gas to new customers, primarily Greece (where negotiations have been continuing since 1985) and Sweden (which has intermittently considered the possibility of taking Soviet gas over the past decade).[31]

(b) To explore the possibility of sales outside long-term contracts with both existing and new customers: the so-called spot trade.

(c) To improve the only weakness in their export performance—inability to maintain deliveries during severe winter conditions.[32]

[30] This is not spare capacity which can be called upon at a moment's notice, but it could be developed by increasing compression and switching over the proportion of transmission capacity in the export pipelines which currently carry Soviet domestic supplies to other pipelines within the Soviet grid.

[31] The Greek volumes being talked about are at 1 BCM by the early 1990s, rising to 3–4 BCM by 2000. Donald O. Croll, "Economic revival boost for energy", *Petroleum Economist*, April 1986, pp. 133–4; "Gas: Fierce Algerian-Soviet Competition for the Greek Market", and "Gas: Acceleration in Greek Negotiations with Algeria and the USSR", *Petrostrategies*, April 7 and June 23, 1986, pp. 2–3 and 3–4; "Greeks head for Moscow with Algerian back-up ready", *International Gas Report*, December 6, 1985, p. 1. Sweden is more likely to try to use the Soviet gas as a negotiating card to force better terms from either the Norwegians or the Danes, "Sweden drops plans to buy Soviet gas", *ibid*, October 12, 1984.

[32] This has been recorded in the press at least three times, in the early months of 1979, 1981 and 1985. *Petroleum Intelligence Weekly*, April 16, 1979, p. 11; Kevin Done, "Moscow Warns

In the *longer term*—after 1990—Soviet prospects for large additional gas sales have been adversely affected by the contracts, concluded in 1986, for sales from the Norwegian Troll field.[33] Accepting that it does not compete on equal terms with OECD gas exporters—because, other things being equal, West European countries will give priority to imports from OECD suppliers—the Soviet Union is likely to concentrate its efforts in two areas: first, ensure that it remains a more attractive source of gas than non-OECD competitors. Second, to attempt to expand into new markets in Western Europe. Attention could centre here on the United Kingdom—the only potential importer with a large-scale market which does not at present receive Soviet gas.

The Complexity of Soviet Decisionmaking: A Framework for Forecasts

Since 1977, there has been a certain amount of rewriting of history concerning how the CIA studies "should have been interpreted," mostly aimed at showing that the Agency was "right after all."[34] It is therefore important to note that, although the CIA *did* correctly identify certain trends in the Soviet oil industry, the features of its studies which gave rise to the tremendous publicity, and which were strongly defended at the time, were the Agency's estimates of: Soviet oil reserves (4.1–4.8 billion tons), Soviet oil production in 1985 (400–500 mt) and CMEA oil imports (175–225 mt) in the same year.[35] Without these forecasts of production and imports, the CIA analysis would have attracted very little public attention. Each of these estimates has been proved profoundly wrong.

The period following the CIA forecast was somewhat counterproductive in terms of Western analyses of the Soviet oil situation, as analysts sought to "prove" that the Agency was either "right" or "wrong." In a number of these studies, the subject of Soviet energy prospects was considered less interesting than speculation on the motives of the CIA in making such a forecast.[36] Many Western forecasts which were critical of the Agency failed to put forward their own figures to be "shot at," and those which did often fared very little better in terms of predictive ability.[37]

Europe of Cut in Gas Supply", *Financial Times*, January 10, 1981; "Weather Reduces Soviet Gas Exports", *Ibid*, January 10, 1985. However, it may be significant that during extremely cold weather in January 1987, no shortfalls in deliveries to West European utilities were reported.

[33] I have described the Troll project and its role in the West European gas market in: "Norwegian Troll Gas: The Consequences for Britain, Continental Europe, and Energy Security," *The World Today*, January 1987, pp. 1–4.

[34] See for example: Maurice Ernst, "Comments on Thane Gustafson's Article", *Soviet Economy*, Vol. 1, No. 2. pp. 136–41.

[35] The import projection is contained in: CIA, *The International Energy Situation: Outlook to 1985*, April 1977. This was based on projections for the domestic oil industry: CIA, *Prospects for Soviet Oil Production*, April 1977; see also *Prospects for Soviet Oil Production: A Supplemental Analysis*, July 1977.

[36] Marshall I. Goldman, *The Enigma of Soviet Petroleum: Half Empty or Half Full?*, London: George Allen and Unwin, 1980, Chapter 8.

[37] David Wilson, *Soviet Oil and Gas to 1990*, London: Economist Intelligence Unit, Special Report No. 90, 1980. However, Goldman, *op. cit.*, which was extremely critical of the CIA, does not advance any of his own forecasts. This author's efforts can be found in: Jonathan P. Stern, "Western Forecasts of Soviet and East European Energy Over the Next Two Decades (1980–2000)" in *Energy in Soviet Policy*, Joint Economic Committee, Subcommittee on International Trade, Finance and Security Economics, U.S. Congress, U.S. Government Printing Office, June 1981.

The Soviets themselves, in their five year plan targets had a generally good record in oil production, at least up until 1980. Their record for natural gas production is mixed, with persistent overconfidence in the period up to 1975, being replaced by persistent overfulfilment (often by large margins) during the past decade.[38] However, the five year targets generally give a better feel for the aims of the planners and it can be misleading for western observers to read too much into yearly targets (Table 1) which can be over or underfulfilled by small margins.[39]

Most of the western, specifically American, forecasts which gained the widest publicity in the late 1970's, were filled with ethnocentric bias, and economic and technical chauvinism. The tone of these commentaries was that the only way to achieve success in a petroleum industry was to organise it along western lines with western equipment and that any other method was doomed to failure. They gave the Soviet fuel and energy industries little or no credit for the impressive results achieved in the 1970's. They took the view that the future was almost unrelievedly bleak and that there was little or no way that the USSR could avoid such a fate. This pessimism was based on the view that Soviet petroleum technology and equipment were so primitive that they could not support higher levels of production.

None of the above should be taken to mean that these commentaries did not identify real problems in the Soviet oil and other energy industries. There is little dispute that in a large number of areas of equipment and technology, the Soviet petroleum industry does indeed lag behind its western counterparts. However, this does not mean that it is impossible to achieve satisfactory results, or that given time, problems cannot be overcome. The major mistake of much analysis was to seize upon one small part of the system and from it to make generalisations about the future of the entire Soviet energy sector. The most obvious example was the notion, in the late 1970's, that Soviet oil production had peaked, or was about to peak. In the event, although gas condensate additions to crude oil production kept the total reported oil production figures from falling until 1984 (crude oil production per se peaked in 1982),[40] it was evident that this would be but one factor, albeit an important one, in determining the future of the entire energy effort in the USSR. Few pointed out that even if Soviet oil production did fall, it might rise again, or remain on a plateau for a number of years.

By the mid-1980's, it had become clear that any comprehensive analysis of alternative Soviet energy futures required a framework which could be conceptualised as a matrix of the four Soviet fuel sectors: oil, gas, coal and primary electricity, plus the potential for conservation and substitution; counterposed against three sets of

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[38] Soviet energy planning failed most dismally in the area of coal production where targets over the past decade have borne virtually no relation to reality. The much improved performance of the industry in 1986 is interesting in this respect.

[39] There is, of course, a question of whether plan targets reflect reasonable expectations, or whether they simply express hopes and exhortations. It is dangerous to speculate that because yearly targets are missed, sometimes by large margins, dire consequences will follow.

[40] On the importance of gas condensates see: Matthew J. Sagers, *Natural Gas Liquids and the Soviet Gas Processing Industry*, Center for International Research, US Bureau of the Census, Washington DC: March 1986, CIR Staff Paper No. 14.

end users: the domestic economy, exports to Eastern Europe (and other allies), and exports for hard currency.[41]

Any attempt to even analyse, let alone make projections for, the individual elements in this matrix is a task of herculean proportions. The mix of economic, political and strategic factors involved in each decision, renders precise quantification impossible. For example how does one attempt to weigh up the political and strategic implications, against the economic benefits, of a Soviet decision to reorient crude oil exports away from East European allies towards the hard currency area? Is it possible to estimate the benefit to the Soviet economy of consuming an additional barrel of oil domestically, aganist the value of goods imported with the hard currency earned from the export of the same barrel to world markets?

Past Western analyses of Soviet oil exports to world markets arrived at projections by determining a level of production, domestic demand and deliveries to socialist countries, leaving the remaining surplus for export to the West. Although the predictions produced by this methodology have been massively wide of the mark (primarily due to problems in forecasting domestic demand), they had the advantage of being relatively uncomplicated in terms of their analysis of the Soviet planning process. In this approach, exports to the West were treated as residual sales, rather than as a target with importance for foreign trade planning. While this was entirely understandable given the lack of information about Soviet foreign trade intentions, it led all Western analysts to miss the most significant and surprising development in the Soviet oil balance in the 1980's—the surge of exports to the West in the period 1982–84, at a time of static production.

It is therefore clear that the methodology for estimating Soviet oil (and to a lesser extent natural gas) exports to OECD countries has to include elements of foreign trade decisionmaking as well as supply and demand analysis, although the latter retains considerable relevance. This is particularly difficult in that the planners publish their expectations regarding the future supply of Soviet fuels, but little or no indication of foreign trade expectations and priorities.

The overwhelming image of the Soviet energy sector in the 1980's, is one of complexity in the allocation of investment among the fuel industries (and conservation efforts), and complexity in the allocation of fuels to end users, given a vast number of interrelated options. Moreover, the criteria on which such decisions are being made is likely to change, depending on (particularly): the performance and perceived vulnerability of the Soviet economy, the political situation in individual East European countries, and the world market price of oil. Thus, when western analysts make projections for the one particular area of the Soviet energy balance which interests them—namely Soviet exports to world markets—it is essential for them to recognise that they are disaggregating this variable from a vast number of elements, *and* second-guessing the planners on their choices regarding a vast number of options. They should

[41] These are only the major elements. On the trade side, one should also be aware of Soviet exports of third country oil and exports to developing countries on a barter basis.

therefore present their conclusions with suitable humility as I shall attempt to do below.

Conclusions

Finally, therefore, it remains to put some numbers to the trends which have been identified above. Despite the numerous warnings, given above, regarding the complexity of the factors involved in such judgments and the failures of past attempts at forecasting, some working numbers are still useful if treated with appropriate caution. This author's firm conviction is that forecasting trends for Soviet oil (and to a lesser extent gas) production and exports beyond a 5-year period is mainly an exercise in guesswork; but worthwhile and interesting guesswork. What follows should be read in that spirit.

Soviet oil production will remain at around 600–620 mt for the remainder of the 1980's, declining slowly in the early part of the next decade and steeply in the mid to late 1990's to around 500 mt by the end of the century. Trying to balance the competing pressures of oil availability and hard-currency earnings, it would be reasonable to expect that by the mid-1990's, oil exports to the West would have fallen to around 40 mt, and by the end of the century to around 25 mt. This decline should not be interpreted as a straight line trend. It may not commence until 1990 and hard currency oil exports may be boosted in years when the need for earnings becomes acute.

Soviet natural gas production will rise steadily to reach around 1000 BCM by the end of the century. The decline in hard currency oil export earings will be partly counterbalanced by gas exports rising to around 50 BCM in the mid-1990's, and to 60–70 BCM by the end of the century, depending mainly on the limitations of the West European gas market. About 5–10 BCM of exports to OECD countries will be sold on soft-currency or barter terms.

Finally, it should be asked, where are my projections most likely to be wrong and for what reasons? Clearly the oil sector is the most difficult area to forecast. I am acutely aware that a fall in Soviet oil exports to one half of current levels over the next 10 years would have major implications for hard currency earnings and trade with western countries. The figures advanced here would also break a long-term trend, whereby, since 1960, more than 10% of Soviet oil production has been exported to world markets; my projections see this falling to around 5% by the end of the century.

I therefore raise four important caveats:

(i) I may have underestimated Soviet hard currency requirements in the short to medium term. Soviet hard-currency earnings from oil and gas exports, which fell by around 18% in 1985 (compared with the previous year), probably fell by a further 30% in 1986. Current projections of real world oil prices do not see a major recovery until the early 1990's (at the earliest) and some see another collapse in prices as a near term possibility. Thus, in the short term, there may be a need to make more oil available for sale to the West, especially if market conditions make it impossible to sell more gas.

(ii) I may have underestimated the potential for energy (specifically oil) conservation and the ability to substitute increasing quantities of other fuels—gas and coal—for oil, in the domestic economy (and to a lesser extent in Eastern Europe).

(iii) I may have overestimated Soviet domestic economic growth and consequent growth in Soviet oil demand. Slow growth in the Soviet economy will retard domestic energy consumption.

(iv) I may have underestimated the willingness to cut back oil deliveries to East European countries in the face of pressing need for domestic consumption and/or hard currency earnings.

Against these four factors, I would argue that there is some potential for oil exports to the West to fall faster then foreseen here, because I continue to be concerned about the volume of investment required to maintain oil production even at lower levels. The production profile which I have suggested would see nearly 8 bn tons of oil being produced in the period up to 2000. Replacing these reserves to ensure the future of the industry into the next century will be an immense task.

The natural gas situation is not so problematic, with production projections resting solely on Soviet ability to cope with the conditions on the northern part of the Yamal Peninsula. My export projections are wholly dependent on the development of the natural gas market in Western Europe, in which Soviet supplies are likely to become an increasingly dominant force, particularly in the next century.

SOVIET ELECTRIC POWER IN THE WAKE OF THE CHERNOBYL ACCIDENT*

By Judith Thornton**

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SUMMARY

On the eve of the Twelfth Five Year Plan, construction of new capacity in the Soviet electric power industry had lagged far behind plan and the energy-intensity of Soviet industrial output remained wastefully high. Nevertheless, by means of intensive use of existing capacity, load shedding at peak periods, and long-distance transmission of power among regions, managers of the power sector were able, for the most part, to avoid serious regional bottlenecks that could have disrupted industrial production plans.

However, as the Twelfth FYP unfolds, the risk grows that shortages of power will constrain other targets for industry. Ambitious plans to produce mine-mouth electric power from eastern strip mines in Siberia and Kazakhstan, at Kansk-Achinsk, Kuznetsk, and Ekibastuz, are slowed by a myriad of problems—lags in construction, technical difficulties with long distance, high voltage transmission of power, and difficulties in designing boilers to burn low calorific, high ash coals at a sufficiently low temperature to avoid slagging and fouling of the boiler. The April, 1986 accident at the Chernobyl nuclear power plant called into question not only the RBMK graphite-moderated reactor technology used at Chernobyl but also the whole ambitious program to base almost all new electric power capacity and much new heat supply in the western Soviet Union on nuclear technology. With little new fossil-fired capacity under construction in western regions and with long time lags in the completion of new electric power capacities, the planners will be severely constrained in their ability to turn to abun-

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dant supplies of natural gas to produce the additional power needed for industrial growth. In the absence of major new investment initiatives or substantial increases in foreign purchases of power equipment, bottlenecks in the delivery of electric power may well disrupt economic plans in important industrial regions by the end of the Five Year Plan.

Production and Consumption

The Soviet Union is second only to the United States in its production of electric power. Soviet power capacity is only 45 percent of the U.S. level—316 thousand MW in 1985 compared to a U.S. capacity of 698 thousand MW in 1985, but, through high levels of off-peak production, this capacity supplies fully 58 percent of the U.S. level of net generation—an estimated 1441 bil kwh of net output in the Soviet Union in 1985, according to data in Table 1, compared with a U.S. output of 2470 bil kwh in 1985.[1]

In 1985, Soviet power capacity, shown in Table 2, was still largely based on fossil-fired thermal electric plants, which accounted for 72 percent of capacity and 75 percent of output. Almost 28 percent of total power output was provided by urban cogenerating plants that, in addition, delivered an estimated 1,403 bil Gkals of heat to centralized district heating and industrial users.

[1] DOE/EIA, Inventory of Power Plants in the United States 1985, August 1986, p. 7 and Electric Power Monthly, December 1986, p. 9.

TABLE 1.—STRUCTURE OF ELECTRIC POWER OUTPUT

	All stations bil kwh	Percent	Hydro-electric stations	Percent	Nuclear power stations	Percent	Total non-nuclear thermal stations	Percent	Including condensing stations	Percent	TETs stations	Percent
Year:												
1960	292.274	100	50.913	17.4	.....	.....	241.361	82.6	.....	.....	.....	.....
1965	506.672	100	81.434	16.1	.....	.....	425.238	83.9	.....	.....	175.0	34.5
1970	740.926	100	124.377	16.8	3.696	0.5	612.853	82.7	352.0	47.5	250.0	33.7
1975	1038.607	100	125.987	12.1	20.205	1.9	892.415	85.9	637.6	61.4	300.0	28.9
1980	1293.878	100	183.889	14.2	72.900	5.6	1037.100	80.2	694.0	53.6	342.0	26.4
1985	1544.000	100	215.000	13.9	167.000	10.8	1162.000	75.3	.....	.....	.....	.....
1985p	1555.000	100	230.000	14.8	220.000	14.1	1105.000	71.1	.....	.....	.....	.....
1986	1599.000	100	214.000	13.4	169.494	10.6	1215.506	76.0	737.5	46.1	470.0	.....
1986p	1605.000	100	216.000	13.5	193.000	12.0	1196.000	74.5	.....	.....	.....	.....
1987p	1665.000	100	218.751	13.1	202.715	12.2	1244.070	74.7	.....	.....	.....	.....
1990p	1840.000	100	245.000	13.3	390.000	21.2	1205.000	65.5	.....	.....	.....	.....

Source: Summary output statistics from "Narodnoe khoziaistvo SSSR," various yeas; "Elektroenergetika," 1977, 42–44, and 1980, 42–44; output by type of capacity from "Elektroenergetika," 1977, 45–49; and 1980, 45–49; Nekrasov and Pervukhin, 1977, 11, 61; Nekrasov and Troitskii, 1981, 11, 13, 29, 129, Campbell, 1979, 10–18.

TABLE 2.—STRUCTURE OF ELECTRIC POWER CAPACITY

Year	All stations thous MW	Percent	Hydroelectric stations thous MW	Percent	Nuclear power stations thous MW	Percent	Total non-nuclear thermal thous MW	Percent	Including condensing stations thous MW	Percent	TETs stations thous MW	Percent
Capacity 1975	217.484	100	40.515	18.6	4.898	2.1	172.071	79.2	99.200	46.0	59.2	27.2
Planned new cap 76–80	71.000	100	13.500	19.0	13.800	19.4	43.700	61.5	24.900	35.1	16.3	23.0
Actual new cap 76–80	49.273	100	11.796	23.9	7.640	16.0	29.837	60.1	19.200	37.5	14.8	30.0
Capacity 1980	266.757	100	52.311	19.6	12.538	4.7	201.908	75.7	118.400	44.4	74.0	27.7
Planned new cap 81–85	60.843	100	12.389	20.4	21.262	34.9	27.192	44.7	12.500	20.5	16.0	26.3
Actual new cap 81–85	49.276	100	9.028	23.0	15.820	38.3	24.428	49.6	.....	.....	.....	.....
Capacity 1985	316.033	100	61.339	19.4	28.358	9.0	226.336	71.6	.....	.....	.....	.....
Capacity 1986	322.000	100	62.900	19.5	30.358	9.4	229.000	71.1	132.0	41.0	89.0	27.6

Sources: Summary capacity statistics from "Narodnoe khoziaistvo SSSR," various years "Elektroenergetika," 1977, 25–29, and 1980, 27–31; capacity by type from "Elektroenergetika," 1977, 26, and 1980, 28; Cambell, 1979, 10–16; Nekrasov and Troitskii, 1981, 129, 141, 200, 282; (Other primary sources used by the author are cited at length in Campbell, 1979.) Cogenerating capacity also from Gorshkov, 1984, 202. Nuclear capacity from "Elektroenergetika," 1977 and 1980 and from authors files.

However, the aggregate shares fail to show the precipitous rise in the share of nuclear power from a mere 2 percent of capacity and output in 1975 to 9 percent of capacity and 11 percent of output a decade later. (The share of nuclear power in U.S. output was somewhat larger, 12.5 percent of capacity and 15.5 percent of output in 1985.[2] Moreover, official targets of the Twelfth Five Year Plan called for a further doubling of the share of nuclear power to 21 percent of output by 1990.

Soviet power production is concentrated in much larger individual plants than in the United States. The 85 major power stations with capacities in excess of 1 million kwt include 60 thermal, 9 nuclear, and 16 hydroelectric stations making use of large generating units which supply more than half of all power output. On average, these plants are operated at 5,138 hours per year, or 59 percent of the time, compared with 3,595 hours per year in the United States in 1984. For thermal electric and nuclear power plants, the load factors are still higher—5,676 and 5,900 hours respectively in 1985.

Achieving such high load factors involves costs as well as benefits. Wheeling power long distances leads to losses in transmission—reported to be 9.4 percent of gross station output in 1984.[3] The costs of load shedding at peak periods are harder to measure, but interrupted delivery of power results in work stoppages for many industrial customers as well. Potentially most costly of all is the deterioration in the parameters of power service. Complaints that the Unified Power System, covering the European USSR, Urals and Transcaucasus, operates at reduced frequency and voltage a large part of the time began to appear in the press in the wake of the Chernobyl' accident. This method of reducing power consumption is risky. Reduced frequency slows small machinery and can damage computers; reduced voltage can cause machines to burn out.

Industry is the prime consumer of electric power, accounting for 59 percent of gross output (including in-station use of power.) The other main categories of use shown in Table 3 are: communal and municipal (14 percent), agriculture (9 percent), transport (8 percent), line losses (9 percent), and export (2 percent).[4] Within industry, the heaviest users of electric power are metallurgy (32.7 percent), chemicals and petrochemicals (15.6 percent), fuels, (10.5 percent) and machine building (16.3 percent).

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[2] DOE/EIA, August 1986, p.7 and Electric Power Monthly, December 1986, p. 16.
[3] Elektricheskie stantsii, No. 3, 1985, p. 2.
[4] Narodnoe khoziaistvo, 1985, p. 54.

TABLE 3.—STRUCTURE OF ELECTRIC POWER CONSUMPTION

Year	Total power output bil kwh	In station use	Power at busbar	Losses in trans	Total cons.	Of which				Indust Gross	Indust net E P station use	Const.
						Ag	Transp	Communal	Export			
1960	292.274	18.672	273.602	17.823	255.8	9.970	17.643	30.365	0.030	207.518	188.846	8.916
1965	506.672	35.202	471.470	35.078	436.4	21.099	37.072	50.642	1.465	349.412	314.210	11.904
1970	740.926	50.492	690.434	58.292	632.1	38.552	54.363	81.082	5.197	488.420	437.928	15.020
1975	1038.607	69.084	969.523	82.191	887.3	73.804	74.201	119.063	11.300	656.782	587.698	21.266
1980	1293.878	85.396	1208.482	106.900	1101.6	110.900	102.800	155.422	19.100	772.900	687.504	25.878
1981	1326.031	87.518	1238.513	107.800	1130.7	113.900	106.600	159.379	20.100	791.700	704.182	26.521
1982	1367.100	90.229	1276.871	112.600	1164.3	120.500	112.000	165.158	21.100	808.400	718.171	27.342
1983	1418.110	93.595	1324.515	115.300	1209.2	126.600	115.500	171.338	23.900	837.100	743.505	28.362
1984	1492.075	98.477	1393.598	126.100	1267.5	137.800	118.900	179.959	24.700	874.800	776.323	29.842
1985	1544.000	101.904	1442.096	133.700	1308.4	145.700	120.100	191.320	28.900	893.600	791.696	30.880
1965p	1605.000	.....	.....	.....	1330.0	157.000	128.000	191.000	30.000	.....	795.000	29.000

Sources: "Narodnoe Khoziaistvo," various years; Nekrasov and Troitskii, 1981, 46–69; Elektroenergetika, 1980, 95.

A comparison of the planned and actual structure of consumption in 1985 in Table 3 tells us how the shortfall in power production was distributed among sectors. Out of a total apparent shortfall of 21.6 bil kwh, more than half—11.3 bil kwh—of the deficit was taken from agriculture, 7.9 bill kwh less was used in transport, and 3.3 bil kwh less than plan was available for industry.

The Performance of Electric Power

Western estimates rank electric power as one of the most rapidly growing sectors of Soviet industry between 1950 and 1980. Table 4 shows that in the first half of the period, power output grew at more than twice the rate of growth of national income, but, growth of output and capacity slowed during the seventies and fell to slightly more than the rate of increase of national income in the eighties. If, in the fifties and sixties net power capacity was rising at annual rates of 13 percent and 9.6 percent, then, in the seventies and eighties, the corresponding rates were only 4.3 percent and 3.5 percent. However, even though growth of power output exceeded growth of national income in all periods, rising rates of use per unit of output put available power capacities under heavy pressure.

TABLE 4.—ELECTRIC POWER GROWTH BY FYP

(In percent)

Average annual growth	National income	Industry	Electric power	Fuel consumption
1951–55	5.5	10.2	13.1	12.1
1956–60	5.9	8.3	11.4	10.0
1961–65	5.0	6.6	11.5	9.5
1966–70	5.2	6.3	7.9	5.9
1971–75	3.7	5.9	7.0	6.3
1976–80	3.0	3.4	4.5	3.2
1981–85		2.3	3.6	2.9
1986–90	3.5–4.0	3.9–4.4	3.6	

Sources: Growth of national income from U.S. Congress, Joint Economic Committee, "U.S.S.R.: Measures of Economic Growth and Development, 1950–80," Washington: U.S. Government, 1982, 21, 201; Leggett, 1986, 7; Growth of power output and fuel consumption from Tables 1 and 11.

TABLE 5.—ELECTRICITY CONSUMPTION PER RUBLE OF NATIONAL INCOME

	National income	
	kwh/ruble	Index
1960	2.00	100
1965	2.64	132
1970	2.57	128
1975	2.84	142
1980	2.92	146
1985	3.00	150

Source: Neporozhnii, 1986, p. 13.

Traditional measures of productivity place the Soviet power industry among the most technologically advanced. Heat rates for power, measuring fuel consumption per unit of output, fell from a level of 505 g/kwh to 326 g/kwh between 1950 and 1985, a use rate lower than in most other Western countries; the average load factor of 5,901 hours in 1984 was well above U.S. rates of capacity

utilization; the shares of large scale units and of thermal units operating with supercritical parameters were both higher than in other countries; at 11 percent, the share of power produced by nuclear plants is high and growing rapidly; and, at 29 percent, the share of cogenerated power is higher than in most other countries.

However, paradoxically, many of the policies pursued in the power sector to improve sectoral indicates reduce the efficiency of other using sectors and hamper the power sector's ability to meet the demands of users. Low heat rates and high load factors reflect, in part, a paucity of peaking capacity and a policy of load shedding rather than serving peak demands. The large size of individual plants and individual units accounts, in part, for the line losses that amounted to nearly 9 percent of total output in 1985. The rising share of boilers operating at supercritical parameters is one of several factors associated with the steady rise in per-unit costs of thermal electric capacity—a cost differential that is probably not justified by the fuel saving of 5 percent or less.

Capital Investment in Power

Since the middle of the seventies, real investment in electric power, measured as units of real capacity, shown in Table 6, has been declining slightly rather than increasing. While the Soviet official value of capital investment in electric power at "comparable prices" of 1969/73 rose steadily from 3,314 million rubles in 1970 to 4,600 million rubles in 1983, the actual increments to new capacity for 1970 and 1983 were declining from 12,000 MW to 8,000 MW. The deceleration in growth of electric power reflects a mixture of planned and unplanned elements. Table 6 shows increments to capacity by Five Year Plan. Additions to electric power capacity grew steadily by Five Year Plan, peaking at more than 51,000 MW during 1966–70 and 1971–75. Since then, capacity increments have been less than 50,000 MW during the last two FYPs—considerably less than the planned increments of 71,000 MW and 68,900 MW included in the Tenth and Eleventh FYPs. Only nuclear power has enjoyed a steady rise in capacity. There were decreases in the increments of new capacity in virtually every other sector of the industry. In the traditional nonnuclear thermal power sector, new capacity increments declined from a peak of 41,041 MW in 1966–70 to a low of 24,428 MW in 1981–85.

TABLE 6.—NEW CAPACITY IN ELECTRIC POWER BY FYP

Source (Thous MW)	1951–55	1956–60	1961–65	1966–70	1971–75	1976–80	1981–85	1986
Total new capacity	17.632	29.475	48.312	51.117	51.334	49.273	49.276	5.967
Nuclear			.310	.642	3.946	7.640	15.820	2.000
Nonnuclear thermal	14.854	20.69	40.539	41.351	38.241	29.837	24.428	2.664
Hydro	2.778	8.785	7.463	9.124	9.147	11.796	9.028	1.561
Network over 35kv (thous KM)	20.019	72.920	182.477	138.721	159.247	163.685	142.500	24.200

Sources: Data cited in Table 2 and "Norodnoe khoziaistvo," various years.

The Twelfth FYP calls for a planned level of power output of 1860 bil kwh which could be achieved with a net capacity increment of 58,000 MW at current load factors if two-thirds of the increment were provided by nuclear capacity, as indicated in the

Twelfth FYP, or a net capacity increment of more than 60,000 MW if half of the new capacity were fossil-fired capacity working at current load factors. An increment to capacity of this size would require substantial increases in the capacity to produce energy equipment or a substantial increase in net imports (including reduction in exports) of energy equipment.

The Cost of New Capacity: Comparable Price Series

Data for electric power show that the addition to new capacity in 1976–85 was smaller than in the previous decade. What does this information tell us about change in the cost of a unit of capacity? Systematic data series on capital investment in industry are published, not in current prices, but in "comparable" prices; they are supposed to reflect the real value of investment at the estimate values of a particular year. Post-war series on investment in industry link together fragments based on estimate values of 1955, 1969, and 1984. Further, the estimate values, themselves, undergo periodic revisions. The 1955 values are said to have been "adjusted" in, at least, 1956, 1958, and 1959. The 1969 estimate prices were adjusted for changes in equipment prices in 1973 and for changes in the costs of construction in 1976.

TABLE 7.—INVESTMENT IN ELECTRIC POWER AT "COMPARABLE" PRICES

	Estimate costs of 1955			Estimate costs of 1969					Estimate costs of 1984	Own year estimate costs
Narodnoe Khoz:	61,62	63,64	67	70,72	73,74	75	76–80	83	N.K. 84	
Year:										
1950	375									375
1951										
1952										
1953										
1954										
1955										
1956	1,314									1,314
1957	1,290									1,290
1958	1,404									1,404
1959	1,430									1,430
1960	1,486	1,455	1,422	1,687						1,486
1961	1,580									1,580
1962	1,738	1,668								1,738
1963		1,798								1,798
1964		2,019								2,019
1965			2,144	2,525		2,525	2,456			2,093
1966			2,237	2,635						2,237
1967			2,337	2,742						2,337
1968				2,749						2,749
1969				2,776						2,776
1970				3,314	3,103	3,103	3,021		3,581	3,314
1971				3,580	3,402	3,402				3,580
1972					3,418	3,418				3,418
1973					3,447	3,447				3,447
1974					3,550	3.434				3,550
1975						3,747	3,649	3,700	4,278	3,747
1976							3,760			3,760
1977							3,840			3,840
1978							3,890			3,890
1979							3,940			3,940

TABLE 7.—INVESTMENT IN ELECTRIC POWER AT "COMPARABLE" PRICES—Continued

	Estimate costs of 1955	Estimate costs of 1969		Estimate costs of 1984	Own year estimate costs
1980		4,190	4,500	5,190	4,190
1981			4,500	5,251	4,500
1982			4,500	5,235	4,500
1983			4,600	5,578	4,600
1984				5,929	5,929
1985				6,664	6,664
1986					

Sources: "Narodnoe Khoziaistvo," various years; Sovet Ekonomicheskoi Vzaimopomoshchi, "Statisticheskii ezhegodnik stran-chlenov soveta ekonomicheskoi vzaimopomoshchi." Moskva: Finansy i statistika, various years.

Table 7 summarizes information on the ruble value of investment at comparable prices from a sample of the Soviet official statistical abstracts, Narodnoe Khoziaistvo, published during the past twenty-five years. These data show two off-setting effects: first, the occasional upward revision of all values when the level of estimate prices is revised and, secondly, the steady downward drift of earlier numbers in between revisions. If we hypothesized that new estimate values were approximately equal to the actual current price values of some sample of capital goods in the designated estimate year, then we would get an approximate investment series at current prices by jumping across changes in estimate costs without making any changes in the underlying numbers for those years. For example, in Table 7 we would assume that the value of investment at current prices was 1314 mil. rubles in 1956, 2776 mil. rubles in 1969, and 5800 mil, rubles in 1984. In between these benchmark years, the value of investment at "comparable" prices would tend to lag behind the value at current prices, but it would catch up again in the year when revision occurred. The revision of estimate prices to a 1969 base resulted in an upward revision of 17.3 percent, based on the change in 1967 value, or 18.6 percent based on the change in the value for 1960. The former number would imply a difference in price level between current and "comparable" prices of 1.2 percent per year between 1955 and 1969. The revision to a 1984 base resulted in up upward revision of 24.1 percent, implying a differential of 1.7 percent per year between 1969 and 1984.

While we can attempt to account for the changes in estimate costs, I am at a loss to explain the downward drift of past estimate values that occurs between revisions of estimate prices. (For example, the stated value of 1970 investment falls from 3314 to 3021 mil. rubles between 1970 and 1976.) I can think of no legitimate statistical adjustments that would systematically reduce past costs and increase future costs. I am tempted to think of this downward drift as a sort of statistical chiaroscuro by which more distant values are made to appear smaller, thus giving the appearance of greater growth over time. The cautionary conclusion that follows is obvious!

Estimates of the unit costs of capacity may be constructed from data on investment in electric power divided by new increments to capacity (Data on net capacity increments are used in the absence

of consistent data on gross capacity increments and retirements.) Using such estimates during periods of rapid growth in real capacity tends to give a false impression of falling unit costs because ruble investment allocated now may result in new capacity only 6–10 years later. During the last two decades, nuclear power capacity is the only data series subject to a strong effect of this sort. Accoring to estimates based on the linked series of investment at "comparable" prices, the average unit cost of new capacity rose gradually at roughly 3 percent per year during most of the post-war period, then increased sharply, at 8.3 percent annually during the Eighties. This apparent sudden increase in costs occurs because of the shift to new estimate costs in 1984. An alternative current-price series for new capacity controlled by the Ministry of Power and Electrification Minenergo, which is constructed from data in the Statistical Abstract of the Power Ministry and the journal *Elektricheskie stantsii*, indicates that investment cost per unit of newly completed capacity was growing at the annual rate of 6.6 percent between 1972 and 1983. This latter series appears to be based on gross new capacity data, since early increments within Minenergo sometimes exceed net new capacity in the total power industry. (Another possibility is that Minenergo series treat as "new capacity" units that are transferred from non-Minenergo to Minenergo jurisdiction.)

TABLE 8.—ELECTRIC POWER: UNIT COSTS OF CAPACITY

	Investment own year estimate cost (Mil. R.)	New capacity total (thous MW)	Unit cost of capacity (R/kw)	Investment Minenergo (Mil. R)	New capacity Minenergo (thous MW)	Unit cost of capacity (R/kw)
Year:						
1950	375	2.500	150.0	369.0		
1951		2,503				
1952		3.133				
1953		3.352				
1954		4.213				
1955		4.431				
1956	1,314	6.224	211.1			
1957	1,290	4.927	261.8			
1958	1,404	5.244	267.7			
1959	1,430	5.626	254.2			
1960	1,486	7.454	199.4	1,428.0		
1961	1,580	7.377	214.2	1,485.1		
1962	1,738	8.363	207.8	1,539.4		
1963	1,798	10.589	169.8	1,666.5		
1964	2,019	10.534	191.7	1,872.1		
1965	2,093	11.449	182.8	1,970.6		
1966	2,237	7.974	280.5	2,077.7		
1967	2,337	8.720	268.0	2,160.6		
1968	2,749	10.777	255.1	2,144.9		
1969	2,776	11.286	246.0	2,519.0		
1970	3,314	12.360	268.1	2,847.9		
1971	3,580	9.215	388.5	3,117.3	11.739	265.6
1972	3,418	10.874	314.3	3,186.5	10.612	300.3
1973	3,447	9.321	369.8	3,224.9	9.108	354.1
1974	3,550	9.883	359.2	3,235.2	8.521	379.7
1975	3,747	12.041	311.2	3,541.5	10.609	333.8
1976	3,760	10.823	347.4	3,538.1	10.615	333.3
1977	3,840	9.498	404.3	3,666.5	9.069	404.3
1978	3,890	7.636	509.4	3,983.7	7.174	555.3

TABLE 8.—ELECTRIC POWER: UNIT COSTS OF CAPACITY—Continued

	Investment own year estimate cost (Mil. R.)	New capacity total (thous MW)	Unit cost of capacity (R/kw)	Investment Minenergo (Mil. R)	New capacity Minenergo (thous MW)	Unit cost of capacity (R/kw)
1979	3,940	9.841	400.4	4,013.9	8.953	448.3
1980	4,190	11.475	365.1	4,266.8	8.455	504.6
1981	4,500	9.965	451.6	4,410.1	8.764	503.2
1982	4,500	8.770	513.1	4,558.3	9.500	479.8
1983	4,600	8.066	570.3	4,870.0	8.000	608.8
1984	5,929	10.135	585.0	5,517.0		
1985	6,664	12.340	540.0	6,400.0		
1986						
An Rt	51–60	1.33	0.029	72–83	2.03	0.066
	61–70	1.34	0.030			
	81–80	1.36	0.031			
	81–85	1.49	0.083			
Tot		3.62	0.037			

Sources: Unit cost of capacity estimated as total investment divided by new net capacity. Total investment from Table 7; Minenergo investment from "Elektroenergetika," 1980, p. 83 and "Elektricheskie stantsii." January, various years; Capacities from "Narodnoe khoziaistvo," various years; Minenergo capacities from "Elektroenergetika," 1980, p. 31.

TABLE 9.—UNIT COSTS OF CAPACITY BY 5-YEAR PLAN

	Investment/new capacity (rubles per kw)						
	1951–55	1956–60	1961–65	1966–70	1971–75	1976–80	1981–85
Total electric power [1]		234.9	191.0	262.4	345.6	398.2	529.7
Total electric power [2]	244.4	219.8		268.0	330.6	410.5	
Construction					206.3	235.0	
Equipment					124.3	175.6	
Nuclear				616.8	387.2	518.7	
Construction					185.0	226.6	
Equipment					202.2	292.1	
Nonnuclear:							
Thermal				171.8	191.6	224.3	
Construction					110.9	121.0	
Equipment					80.8	103.3	
Hydro				335.4	352.6	352.4	
Construction					264.7	251.3	
Equipment					87.9	101.1	
Network					24.1	25.0	
Construction					15.2	14.3	
Equipment					9.0	10.7	

[1] Investment from Narodnoye Khoziaistvo.
[2] Investment from Minenergo Statistical Abstract.

Sources: Unit cost of capacity estimated as total investment divided by new net capacity. Capital investment from sources in Table 8 plus Nekrasov and Troitskii, 1981; Nekrasov and Pervukhin, 1977; Pavlenko, A.S. and A. M. Nekrasov, 1972, "Energetika SSSR v 1971–1975 Godakh." Moskva: Energoizdat, Neporozhnii et al. "Gidroenergetika i kompleksnoe ispol'zovanie vodnykh resursov SSSR." Moskva: Energoizdat, 1982, p. 172.

The sources of upward drift in the capital costs of electric power are: (a) the increased share of capital-intensive nuclear power, (b) the rising unit cost of each individual type of power capacity, and (c) the growing costs of activities attributed to overhead and not allocated to investment in individual plants. In the 1961–65 FYP, 73 percent of investment was allocated to construction of stations; in the 1976–80 FYP, that share had fallen to 68 percent of all investment resources.

There are strong institutional reasons why nominal estimate costs of new capacity might fall short of full costs. Comments by engineers suggest that there is considerable effort by designers of

each type of energy technology to justify low cost forecasts and superior technical parameters for thier own type of technology. When future investments are under consideration, cost comparisons are based on calculations of projected *privedennye zatraty,* or full costs of power, (measured as current operating costs plus a percentage norm on the estimate cost of fixed capital.) Since these calculations assign a percentage charge to the estimate costs of the new power plant, design changes that raise estimate costs reduce the apparent desirability of the technology in question particularly if such changes do not increase the normative productivity or fuel efficiency of equipment. Table 10 presents examples of the cost calculations made by power engineers in comparing the cost-effectiveness of nuclear and fossil-fired thermal electric plants. Column 3 presents a cost calculation by A.S. Gorshkov based on estimate values for construction in 1983.[5] His calculations use a discount rate of 8 percent to adjust for the longer construction time of nuclear plants and then apply an annual interest charge of 12 percent to fixed and working capital stocks. Annualized capital costs plus operating costs result in a full cost of 120.7 million rubles for 2,000 MW of nuclear capacity or 146.6 million rubles for 1,950 MW of fossil-fired thermal capacity—an annual cost saving of 25.9 million rubles for nuclear power.

TABLE 10.—COST COMPARISONS FOR NUCLEAR AND THERMAL PLANTS

(1)	Calculation (2)	Estimate cost (3)	76–80 investment cost (4)	20 percent increase in cost of nuclear capacity (5)	20 percent increase in cost of nuclear + fuel cost (6)	40 percent increase in cost of nuclear + fuel cost (7)
Costs of nuclear plant:						
1. Time to completion, years	t–T				45 rubles	45 rubles
2. Discount rate for present value	0.08					
3. Total capacity, MW		2,000				
4. Capital investment (mil r)	Estimate value	360	1,037.4			
5. Working capital (mil r)	Estimate value	60				
6. Fixed and working capital (mil h).	(4) + (5) = Kt	420	1,097.4	1,316.9	1,316.9	1,536.4
7. Capital cost with interest (mil h)	(2) x Kt	484.4	1,265.3	1,518.4	1,518.4	1,771.4
8. Annual capital charge at 12 percent.	0.12 x (7)	58.1	151.8	182.2	182.2	212.6
9. Capacity in use, MW		2,000				
10. Annual output (bil kwh)		13.9				
11. Annual operating costs (mil r)		62.6	62.6	62.6	62.6	62.6
12. Annual full cost (mil r)	(8) + (11)	120.7	214.4	244.8	244.8	275.2
Costs of thermal plant:						
13. Total capacity, MW		1,950				
14. Capital investment (mil r)	Estimate value	266.6	448.6	448.6	448.6	448.6
15. Discounted capital cost (mil r)	(2) x Kt	251.4	403.7	403.7	403.7	403.7
16. Annual capital charge at 12 percent.	0.12 x (15)	30.2	48.4	48.4	48.4	48.4
17. Annual output (bil kwh)		13.6				
18. Annual fuel consumption (thous t)	Standard fuel	4,630				
19. Annual fuel cost (mil r)	20 r/ton	92.6			208.4	208.4
20. Other costs (mil r)		28.6			28.6	28.6

[5] Gorshkov, 1984, p. 225.

TABLE 10.—COST COMPARISONS FOR NUCLEAR AND THERMAL PLANTS—Continued

	Calculation	Estimate cost	76–80 investment cost	20 percent increase in cost of nuclear capacity	20 percent increase in cost of nuclear + fuel cost	40 percent increase in cost of nuclear + fuel cost.
(1)	(2)	(3)	(4)	(5)	(6)	(7)
21. Total operating costs (mil r)	(19) + (20)	121.2			237.0	237.0
22. Discounted operating costs		114.4	114.4	114.4	223.7	223.7
23. Annual full cost	(16) + (22)	146.6	162.8	162.8	272.1	272.1
24. Annual cost savings from nuclear (mil r).	(23) – (12)	25.9	–51.6	–82.0	27.3	–3.1

Source: Based on calculations in Gorshkov, 1984, p. 225.

In columns 4–7 of the same table, I show how changes in assumptions about the capital costs of nuclear plants or the fuel costs of thermal electric plants can influence the outcome of such comparisons. Column 4 presents the cost comparison when capital costs are measured by the actual unit investment costs of 1976–80. In this case, the nuclear plant costs 51.6 million rubles more per year than the equivalent thermal electric plant. Column 5 presents the same calculation on the assumption that the cost of improved safety systems introduced after the Chernobyl nuclear plant accident increases the capital cost of nuclear plant to 40 percent more than 1983 estimate cost. This assumption makes the annual costs of the nuclear plant 82 million rubles more than the thermal electric plant. Column 6 presents the cost comparison on the assumption that the price of fuel charged to fossil-fired thermal electric plants equalled the calculated marginal cost of fuel in the Western part of the Soviet Union, 45 rubles per ton of standard fuel, which. once again, gives the nuclear plant the cost advantage. Clearly, these important long-run investment choices are very sensitive to small changes in underlying assumptions.

Such calculations for separate regions of the country were used in drawing up the Eleventh and Twelfth FYPs to justify construction of new nuclear and gas-fired plants in the central USSR, new hydroelectric and coal-fired thermal electric plants in Siberia, and a mixture of gas-fired, coal-fired, and nuclear plants in the Urals. This strong regional specialization presents planners with a dilemma in the wake of the accident at the Chernobyl nuclear plant, for there is relatively little new fossil-fired capacity under construction or planned in the Central and Southern power regions. Any significant slowing in the construction of nuclear plants while design changes are contemplated risks creating a worsening regional bottleneck. In 1986, power planners offset the reduction in nuclear capacity by burning above-plan quantities of fossil-fuels in fuel-intensive peak and semi-peak units.

The Structure of Fuel Consumption

In 1960, the Soviet power industry was largely coal-based. Four fifths of power came from conventional fossil-fired thermal electric plants, and coal fueled more than three-quarters of these plants. Then, during the sixties and early seventies, the industry instituted technological measures to improve productivity by reducing the

fuel consumption per unit of output. These rapid reductions in heat rate were achieved by speeding the production of large generating units of 300 MW or more which were linked into large, interconnected power grids and by shifting a portion of thermal electric capacity away from coal and into fuel oil and gas. In consequence, in 1975, the Soviet Union was producing 87.2% of its power from traditional thermal electric stations (compared with a share of 74.3% for such stations in the US.) Further, the share of solid fuels (coal, peat, and shale) in the Soviet fuel balance had fallen to 48% at a time when coal accounted for 59.3% of U.S. thermal power production. Thus, as Table 11 shows, the Soviet power industry was a heavy consumer of fuel oil and gas just at the time when the rapid increase in world prices of oil and gas made these products valuable to the Soviet planners as a potential source of hard currency revenue.

TABLE 11.—STRUCTURE OF FUEL CONSUMPTION IN MINENERGO

	Minenergo of which:								
	Fuel Cons Thous T St. Fuel	Coal Cons ThsTSF	Percent	Oil Cons ThsTSF	Percent	Gas Cons ThsTSF	Percent	Shale peat wood	Percent
Year:									
1955	60,267	44,782	0.743	5,661	0.094	2,345.9	0.039	7,952	0.132
1960	107,693	72,154	.670	8,939	.083	15,939	.148	10,662	.099
1965	193,545	113,998	.589	22,064	.114	43,548	.225	13,935	.072
1970	278,025	135,140	.486	63,955	.230	64,233	.231	14,737	.053
1975	381,028	169,545	.445	112,395	.295	83,826	.220	15,241	.040
1980	448,641	167,343	.373	160,165	.357	108,571	.242	12,562	.028
1981	453,300								
1982	466,836								
1983	479,360	162,503	.339	148,602	.310	158,189	.330	10,067	.021
1984	497,223	163,586	.329	140,217	.282	181,984	.366	10,442	.021
1985	514,310	174,865	.340	133,720	.260	195,438	.380	10,286	.020
1985p	496,062	196,440	.396	128,480	.259	156,259	.315	14,882	.030

Sources: Consumption of total fuel estimated from Minenergo thermal power output in "Elektroenergetika," 1980, p. 50 and heat rates from "Narodnoe khoziaistvo," various years, Campbell, 1979, p. 20, Promyshlennost SSSR, 1957, p. 181.
Percentage structure of fuels from "Elektroenergetika," 1980, p. 49, Nekrasov and Troitskii, 1981, Nekrasov and Pervukhin, 1977, Pavlenko and Nekrasov, 1972, Neporozhnii, 1986, and "Elektricheskii stantsii," January, various years.

The Ministry of Power and Electrification responded to calls to reduce consumption of oil with an investment program to speed the construction of power capacities based on other sources of energy. Both the 1976–80 and 1981–85 FYPs included measures providing accellerated completion of nuclear power plants in the Western USSR and of hydroelectric and coal-burning capacities in the East.[6] These measures, as well as construction of new cogenerating capacity, did offer some saving of total fuel. A 1975 output of 1039 bil kwh of power and 918 bil Gkal of heat required an estimated 445 mil tons of standard fuel, while 1985 output of 1097 bil kwh of power and 1403 bil Gkal of heat consumed, at most, an estimated 600 mil tons of standard fuel.

If the 1986 output of nuclear power plants of 162 billion kwh had come from fossil-fuel fired plants at an average heat rate of 325.9 g/kwh, it would have required an additional 52,796,000 tons of

[6] Nekrasov and Pervukhin, 1977, p. 19 and Nekrasov and Troitskii, 1981, p. 36–37.

standard fuel. And the construction of approximately 24,000 MW of cogenerating capacity during the decade saved an additional 5,186,000 tons of fuel in electric power production alone and considerably more than that if fuel savings from heat are included as well.[7]

However, in spite of these charges in capacity, actual use of fuel oil in power stations was larger in 1985 than in 1975. According to preliminary data in Table 11 estimated consumption of fuel oil by Minenergo power stations rose from 112 million tons of standard fuel in 1975 to more than 160 million tons in 1980 before falling to 134–140 million tons in 1984–85.[8] If anything, these estimates appear to understate the actual consumption of fuel oil in power plants in the Eighties because they may not take into account the growing use of oil in coal-fired power plants.

There are a number of factors in the continued heavy reliance on oil in power plants. One is the lack of depth of refining capacity and inability to use oil in the form of lighter refined products.[9] A second one is the falling calorific content of energy coals.[10] A third is the inability to supply gas-and oil-fired power plants with natural gas on a year-around basis.[11] Still another is lags in the completion of planned nuclear capacity in the West and of coal-fired capacity in the Ekibastuz and Kansk-Achinsk basins. All these developments contributed to major deviations from the planned structure of fuel use.

The potential for fuel-saving in electric power appears to be somewhat less in the coming decade than in the past. For plants of 300 to 500 MW in size, the effect of scale on fuel economy is modest. Production of new cogenerating capacity at approximately 3 thous MW per year offers real economic benefit only if there is genuine simultaneous demand for the cogenerated heat. Continued decline in the average quality of coals burned and increased use of peaking capacity will also offset the potential gains in fuel economy to be expected from increased reliance on natural gas and technological modernization of obsolescent capacity.

If the growth of fuel consumption keeps pace with power output, then the power industry will be consuming 377 million tons of standard fuel for electric power alone in 1990 to produce the planned thermal power output of 1205 bil kwh (1156 bil kwh of power at the busbar.) The apparent deceleration in the growth of non-nuclear thermal power will ease some of the pressure on the fuel sector. Nevertheless, the rapid rise in the costs of extracting and transporting both oil and natural gas, mean that this demand for fuel can be supported only by transferring a still larger share of investment resources into the fuel sector—a possibility that stands in stark conflict with Gorbachev's other goals for restructuring the investment sector.

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[7] Fuel savings calculated assuming 3700 hours per year of cogenerated production at 269.6 g/kwh of cogenerating heat rate compared with a heat rate in condensing plants of 355.

[8] These estimates by the author derive series for consumption of total fuel from official heat rates and power at the busbar. Then, total fuel consumption is apportioned among fossil-fuel sources using estimates of percentage structure from the journal, *Elektricheskie stantsii*, and from other industry publications cited in footnotes to the tables.

[9] Sagers and Tretyakova, 1986.

[10] Cooper, 1986 and Roddatis and Shakhsuvarov, 1985, p. 6.

[11] Sagers and Tretyakova, 1986 and Cooper, 1986.

Forecasting Future Performance in Electric Power

In the wake of both radical changes in the world market for fuels and the catastrophic accident at the Chernobyl nuclear power plant, Soviet medium-term plans for the power sector are still unsettled. A delay of more than a year in the publication of the industry's basic document on the Twelfth FYP, *Energetika SSSR*. suggests a major re-thinking of technical choices. Nevertheless, in a sector in which the design, construction, and commissioning of a new nuclear power plant requires 13 years, structural changes will not come easily or quickly.

The higher costs and time delays required to design safer nuclear power plants will weigh against the rapid pace of nuclear plant construction embodied in current plans. The lower prices of oil and gas in Western Europe, domestic availability of natural gas, and need for flexible peaking capacities all increase the potential attractiveness of gas-fired capacities for both power and cogeneration. Major technological improvements in power equipment available in the West, such as large gas turbine units, high-temperature supercritical steam turbines with double-reheat designs, and fluidized bed combustion designs, would offer the Soviet planners the opportunity to make technological changes in their power mix more quickly than they could hope to achieve through domestic supply, although decreases in hard-currency earnings following the fall in the price of oil intensifies the competition for foreign exchange.

TABLE 12.—FORECAST OF POWER CAPACITY TO 1995

	All stations (thous MW)	Hydro-electic stations (thous MW)	Nuclear power stations (thous MW)	Non-nuclear thermal stations (Thous MW)
1985	316.033	61.339	28.358	226.336
Forecast:				
1986	326.170	63.303	32.402	230.465
1987	336.285	65.276	36.611	234.398
1988	346.388	67.257	41.016	238.115
1989	356.483	69.243	45.634	241.607
1990	366.574	71.231	50.475	244.867
1991	376.661	73.222	55.547	247.892
1992	386.747	75.214	60.852	250.681
1993	396.832	77.207	66.393	253.232
1994	406.917	79.201	72.172	255.543
1995	417.001	81.196	78.189	257.617
	Total K	Coefficient, T	10.083	
		Rho	0.604	
	Hydro K	Coefficient, T	1.995	
		Rho	0.671	
	Thermal K	Coefficient, T	12.966	
		Coefficient, Tsq	−0.120	
		Rho	0.568	
Index 90	1.16	1.16	1.78	1.08
An rt	.03	.03	.12	.02
Index 95	1.14	1.14	1.55	1.05
An rt	.03	.03	.09	.01

In the absence of a substantial infusion of new equipment from the West, the future investment pattern in the power industry will be substantially limited by supply constraints on equipment and

construction resources and by projects already in the pipeline. In this case, projected investment in the next decade may be forecast from the levels and rates of change of investment in the past. After comparison of a variety of alternatives, the forecasts of power capacity to 1995 presented in Table 12 make use of a linear time trend (non-linear time trend in the case of thermal electric power) plus a Cochrane-Orcutt procedure to deal with autocorrelation of error terms in the time trend. These projections posit the completion of approximately 50.5 thous MW in each of the next two FYP, bringing total power capacity to 417 thous MW in 1995. New nuclear capacity is projected to increase from 22 thous MW in the current FYP to 27.7 thous MW in the 1990–95 plan, an increase from 44 percent to 55 percent of total new capacity. New thermal electric capacity is projected to decline from 49.6 percent of total capacity in the 1981–85 plan to 36.6 percent in 1986–90 and, then, to 25 percent of total new capacity in 1990–95. New increments to hydro capacity stay constant at current levels.

These forecasts indicate that, with business as usual in the power industry, and with past patterns of energy intensity, growth of power capacity will be clearly inadequate to support the planned rates of growth of national income. Unless the planners themselves draw the same conclusion and shift new resources into the power sector, electric power will be a major bottleneck by 1990 and Soviet consumers will find themselves cold and in the dark with increasing frequency.

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JOURNALS AND STATISTICAL ABSTRACTS

Elektricheskie stantsii.
Narodnoe khoziaistvo SSSR.

DEVELOPMENT OF THE USSR'S EASTERN COAL BASINS

By David Warner and Louis Kaiser*

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SUMMARY

Expanded coal use underpins the Soviet Long-Term Energy Program; planners are counting on coal, in conjunction with nuclear power, to provide nearly all new energy output once natural gas production levels off in the mid-1990s. Barring unexpected infusions of additional investment and technological breakthrough, however, the USSR may have difficulty approaching its goals for coal development.

The Soviets are banking on the development of selected coal basins in the eastern USSR, but progress in overcoming technical problems related to the transport and use of coal from these basins—Kuznetsk, Kansk-Achinsk, and Ekibastuz—has been slow. Despite the recent increase in coal output, much remains to be done before coal can fulfill the role anticipated by Soviet planners. The USSR has focused on its ability to surface-mine vast amounts of coal cheaply but may have also underestimated the technical problems and costs of using this very low quality coal. In short, eastern coal may be an energy reserve requiring research and investment funding far out of proportion to the gains achieved by meeting planned targets for coal output and use.

Because of coal's enormous reserve base and because of dwindling high-quality reserves of oil and eventually even of gas, the USSR will likely continue to emphasize coal in its long-term energy plans. It may, however, not devote the resources needed in the short term to overcome fundamental obstacles to expanded use. The immediate investment needs of the oil and gas industries and

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modernization of the machine-building sector during 1986–90 could take priority.

The competition among energy suppliers for new resources is likely to reach an important turning point by 1990. At this juncture, Soviet energy policy makers will need to make critical resource commitments among the coal, natural gas, and nuclear options that will largely determine the shape of the USSR's energy supply after 2000. The leadtimes for major project completion in all the energy industries dictate that large new programs be started 10 to 15 years in advance of needs. The remainder of the 1980s will therefore be a trial period for Eastern coal development, a time when schemes for large-scale surface mining and mine-mouth power generation must prove themselves viable or risk losing out in the bidding for resources.

I. Changing Role of Coal in the Soviet Energy Scene

Coal, once the USSR's main energy source, was overtaken by oil in the late 1960s and by gas in the 1970s. Soviet energy planners, however, are counting on additional coal production, in conjunction with nuclear power, to satisfy nearly all of the growth in energy demand by the year 2000.[1] This goal is embodied in the USSR's Long-Term Energy Program, published in 1984. The major expansion of coal production called for in this program will depend on sizable increases in output at selected large surface mines and the development of reliable, cost-efficient means of transporting and utilizing energy from coal.

II. Trends in Underground Mining

Growth in coal output was, until the late 1970s, provided largely by expansion of underground mining. This option, however, is no longer practical. Coal production at most of the major basins relying on underground mines is now essentially stagnant. From 1980 to 1986, the total annual output from underground coal mines fell by 17 million tons, to 428 million tons.

Coal production in the Donets basin—the USSR's largest producer—declined from a peak of 225 million tons in 1976 to 197 million tons in 1985 and will continue to fall during the balance of the 1980s. After more than two centuries of mining, the easily exploitable reserves in this basin have been exhausted. In terms of mine depth, seam thickness, and methane concentrations, most of the Donets mines would no longer be considered proved reserves by Western standards. The average depth of the Donets mines in 1982 was about 605 meters—eight times as deep as the average U.S. coal mine. The average thickness of Donets coal seams in 1980 was less than 1 meter—three-fourths as thick as the seams being worked a decade earlier and about one-half as thick as average coal seams in the United States. Moreover, most of the Donets mines have dangerously high concentrations of methane.

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[1] The "Draft Guidelines for Economic Development During 1986–90 and Through 2000" also call for construction of large coal-fired power plants. The Draft Guidelines, however, do not provide output projections beyond 1990 and do not discuss the relative roles of the different fuels during this time frame.

Similar problems underlie declining production at other Soviet underground coal basins. Output from the Karaganda basin has been flat since 1980. Production from the Moscow basin—where the mining conditions are even more severe than in the Donets basin—has dropped substantially since production peaked in 1960.

III. Trends in Surface Mining

Not surprisingly, Soviet energy planners have opted not to seek growth of coal output through high outlays on costly mining innovations and new capacity in underground operations. Instead they have embraced the goal of expanding surface mining as the most cost-effective way to boost coal output. The share of surface-mined output in total coal production increased from roughly one-fourth in 1970 to about two-fifths in 1985. During this period, the coal industry boosted the annual output of surface mines from 167 million tons to 305 million tons.[2] Growth of coal production from this activity has slowed considerably in the last decade—dropping from an average annual rate of nearly 6½ percent during the 1970s to about 2½ percent currently.

Coal output from surface mining grew rapidly in the 1970s because of the working of new mines and because relatively simple solutions were available for the attendant problems in coal transportation and consumption. Coal production from new mines in Kazakhstan, West Siberia, and the Far East was accommodated by relatively short hauls on existing rail systems. The coal was used in small-to-medium-sized boilers at existing and newly built power plants where proven technology could be readily adapted to burn the lower quality coals from the new surface mines.

In the 1980s, however, the Soviets began to push a new, more complex, and costlier approach to surface mining and coal use. The expansion of surface mining is being concentrated at a few mines in a small number of coal basins. Long-term goals call for yearly production of nearly one billion tons by the year 2000. Interim goals are no less ambitious: nearly 800 million tons by 1990 and about 900 million tons by the mid-1990s. Virtually all of this growth is to come from surface mines east of the Urals, with the Kuznetsk, Ekibastuz, and Kansk-Achinsk coal mines designated as the main producers.

IV. The Key Eastern Basins: Energy Possibilities and Exploitation Headaches

To move coal back to the forefront of energy production and use, the Soviet Union must find and implement technological solutions to two key problems.

First is the low quality of the coal. Most of the USSR's eastern coal reserves are low in energy value, comprising lignites (often with high moisture content or subbituminous coals with a high ash content. These coals require unique approaches to mining, transportation, and combustion.

Second is the problem of distance. The major coal deposits that the Soviets want to develop are thousands of kilometers from the

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[2] *Narodnoye Khozyaystvo SSSR in 1985*, p 157.

industries and population centers most in need of the energy. Consequently, low-cost energy transportation is essential to the viability of any coal-development scheme.

There are a number of technology options Moscow can employ, singly or in combination, at each of the key coal basins. These include new approaches to problems in coal mining and transportation, coal combustion, and synthetic fuel (synfuel). Current Soviet planning for coal technologies calls for widespread use of bucket-wheel excavators for high-volume surface mining; application of coal-slurry pipelines primarily to the transportation of the relatively high-grade Kuznetsk coal; extensive use of mammoth, mine-mouth powerplants with ultra-high-voltage (UHV) electricity transmission from the Ekibastuz and Kansk-Achinsk powerplants to distant consumers; and exploitation of the synfuel alternative primarily at Kansk-Achinsk.

Coal production from Ekibastuz and Kansk-Achinsk could be constrained by the failure to bring the accompanying powerplants on line as scheduled. In both basins, mines were developed as suppliers for mammoth power complexes of 4,000 to 6,400 megawatts (MW) capacity to be linked, in turn, to distant demand centers via UHV transmission lines. However, power industry managers have yet to move these coal-use technologies from design concepts through the various stages of development necessary for commercial application—in part because of the very low quality of the coal being supplied. Soviet UHV technology is also behind schedule. If the USSR is to meet the presently postulated goals for energy production from surface-mined coal, the power industry must put these systems into commercial operation during the 1980s and 1990s, largely without adequate testing for working out the bugs and improving the designs.

A. KUZNETSK COAL: GOOD QUALITY BUT POOR LOCATION

Kuznetsk coal will be particularly important as a replacement for coal from the Donets basin, the principal producer of Soviet high-grade steam and coking coal. The Kuznetsk coal basin already provides about one-third of the coking coal produced in the USSR. The Soviet media repeatedly emphasize that more Kuznetsk coking coal needs to be delivered to the Ukraine and Moscow regions. Kuznetsk coal would also be an acceptable substitute for Donets steam coal: it has a relatively high heating value of about 5,500 kilocalories per kilogram (kcal/kg), a low sulfur content (about 0.5 percent), and a low ash content (15–20 percent).

The Kuznetsk coal basin has the reserve base to sustain increased production over the long term. Soviet technical journals report that the basin has over 117 billion tons of economically exploitable reserves. Moreover, the reserve base for strip-mining operations is reportedly adequate to support production at the target rate for at least 70 years. Operation of surface mines is much more productive and less labor intensive than underground mining.

Despite the relatively high quality and vast abundance of Kuznetsk coal and the reported emphasis on using it to offset declines in the availability of Donets coal, output in the Kuznetsk basin has been lagging since 1975. After reaching 149 million tons a year in

1979, output has been erratic.[3] Sluggish production at Kuznetsk can be attributed primarily to labor shortages, delays in the commissioning of new mines, and transportation bottlenecks.

Inadequate railroad capacity may be a major obstacle to expanded production at the Kuznetsk basin during the late 1980s and 1990s. A Soviet press statement indicated that the "disproportion between the output of coal and the possibilities for its transport will continue to grow."[4] A 1983 Soviet press report also complained that an imbalance between coal production and available transportation was constraining coal production in the Siberian coal basins.[5]

A place for coal slurry pipelines

Coal-slurry pipelines are a practical alternative to railroad bottlenecks. According to Soviet coal-industry journals, the capital investment required for a coal-slurry pipeline to transport coal from the Kuznetsk basin to the Urals would be only about 50 percent of that needed to finance construction of a new railroad.[6] In addition, Soviet estimates indicate that operating costs for a 2,000-km, 25-million-ton-per-year coal-slurry pipeline would be about 6 rubles per ton compared with 10.5 rubles per ton for transport of Kuznetsk coal by rail. Because most of the coal-slurry pipeline system would be automated, its operation would require only about 5 to 10 percent of the personnel required for railroad operation and maintenance. The use of slurry pipelines would also substantially alleviate shortages of railcars for hauling coal from other deposits and ease the strain on railroad traffic capacity. Soviet press statements indicate that the use of a coal-slurry pipeline to transport 3 million tons annually would supplant the daily dispatch of two railroad unit trains of about 80 railcars each.

The USSR faces new technological challenges in the construction and operation of long-distance, large-capacity coal-slurry pipelines. Thus far they are only operating two short (10 to 15 km) coal-slurry pipelines in the Kuznetsk basin. One transports coal to a power plant at Belovo and another to a metallurgical plant at Kuznetsk. For these pipelines, the coal-to-water ratios are 1:7 and 1:12, respectively, and the "particle size" for the coal is in the range of 50–100 millimeters (mm). For the long-distance, large-capacity pipelines, in contrast, the particle size of the coal must be very small—well below 1 mm—and the concentration of solids in the slurry mixture is usually 50 percent or greater.

During 1986–90, the USSR plans to build a 250-km, 3-million-ton-per-year coal-slurry pipeline—a prototype line with a coal-to-water ratio of 65 to 70 percent—from the Belovo mine in the Kuznetsk region to a powerplant under construction at Novosibirsk. Coal-slurry technology for this project is being supplied by the Italian firm Snamprogetti.[7]

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[3] *Zgol'*, March 1986, p. 7.
[4] *Pravda*, 23 October 1985.
[5] *Sotsialistik Qazaqstan*, 19 October 1983.
[6] *Trud*, 21 May 1978.
[7] *Coal Week International*, August 28, 1985, p. 7.

The cold winter temperatures in Siberia will have to be taken into account but probably will not impede pipeline operation. A coal-slurry pipeline in the United States operates regularly during the winter with air temperatures often below zero degrees Fahrenheit. Prevention of freezing would still require special precautions at the slurry-preparation facility, pumping stations, and power plant—especially if a prolonged shutdown occurs.

Variations in terrain elevation should pose no major obstacle to operation of the Belovo-Novosibirsk coal-slurry pipeline. A profile of the route indicates that the pipeline will traverse relatively flat terrain. Some of the steepest gradients are about 2 degrees. In contrast, the steepest gradient for a coal-slurry pipeline operating in the United States is about 18 degrees. The US pipelne traverses generally rough terrain, some of which is mountainous.

Although the Soviet Union have been working on developing coal-slurry technology since 1978, they lack necessary expertise and experience in all three major aspects of systems that supply slurry for direct-burning—creating, moving, and burning the coal slurry. Direct-burning technology is state of the art, and long-distance transport of a 70-percent slurry has not been demonstrated anywhere on a commercial scale.[8]

Future slurry pipeline plans

The Soviet press has reported plans to build coal-slurry pipelines with capacities of about 15–25 million tons per year. Eventually, the Soviets probably hope to use slurry lines to supply coal to a variety of consumers. Because energy prices are in a slump and coal-slurry pipeline technology is still unproven on such a scale, the USSR will likely not build these pipelines until the 1990s at the earliest.

CONVENTIONAL VERSUS DIRECT-BURNING COAL-WATER SLURRIES

Conventional (50 percent coal)	Direct-Burning (70 percent coal)
Technology is proven on a commercial scale.	Technology is unproven for long-distance pipelines. Potential problems with settling of larger particles, degradation of the chemical additive and wear of burner nozzles.
Capital cost is about the same as for direct-burning system.	Capital cost is about the same as for conventional system.
Low operating cost.	Operating costs are nearly twice as high as for conventional system because of cost for chemical additives.
Requires dewatering.	Does not require dewatering.
Little volume control.	Substantial volume control.

B. EKIBASTUZ COAL: MORE ROCK THAN COAL

The Soviets estimate that economically exploitable coals reserves at Ekibastuz and the nearby Maykyuben deposits amount to about 15 billion tons, nearly 9 billion tons of which have been confirmed through exploration. Given the ultimate annual output planned for

[8] The 70-percent-coal water-based slurry technology being sought by the USSR requires that the coal have low ash and low inherent moisture. This makes Kansk-Achinsk (about 40 percent inherent moisture) and Ekibastuz coals (40 percent or more ash) unlikely candidates for a pipeline system to supply slurry for direct burning.

Ekibastuz-Maykyuben—150–170 million tons—the proven reserves would last for at least 55 years. Statements by coal industry officials indicate that they do not expect Ekibastuz-Maykuben output to reach this level until the mid-1990s at the earliest. The success of the effort to double output in the Ekibastuz region in the next decade would require improvements both in the production and operation of mining equipment and in combustion equipment.

The Ekibastuz coal basin has two operating mines, Bogatyr' and Severnyy. These mines produced about 50 million tons and 24 million tons of coal, respectively. Soviet plans for 1990 call for expansion at Severnyy and construction of a new mine, Vostochnyy. Ekibastuz coal output is to increase to about 105 million tons annually when these plans are implemented.

The Soviets classify Ekibastuz coal as a high-ash, subbituminous fuel. This coal is a problem fuel for consumers: the ash content (noncombustible matter) can range from 40 percent to nearly 60 percent, and the energy value is only about 3,500 kcal/kg. The marked contrast between the high ash content of Ekibastuz coal delivered to power-plant customers and the inherent ash content contained in the coal seams (averaging about 40 percent) suggests that mining operations are slipshod or that mining techniques are not sufficiently discriminating. The high ash level is undesirable because it accelerates wear on coal-handling equipment such as pulverizers, increases the chance that equipment failure will force power-plant boiler shutdown, and adds to the transportation burden of railroads and conveyor systems. The low heat content of Ekibastuz coal (about half that of the highest quality Soviet coal) means that the entire combustion system of the consuming plant must be larger and more durable than a system of equivalent capacity at a plant fueled with a better coal. These requirements boost the investment cost for new plants and lengthen their construction time

Ekibastuz coal is used solely as a boiler fuel, primarily in power plants. The Soviets plan to concentrate Ekibastuz coal usage through the early 1990s at five 4,000-MW power plants, four of which are being built close to the mines. The fifth plant is sited in southern Kasakhstan. The boilers at these plants are to be specially configured to deal with the technical properties of Ekibastuz coal.

The first 4,000-MW powerplant, Ekibastuz Gres 1, was finished during 1984. At the planned operating rate, each of the five plants in the series would use nearly 16 million tons of coal annually to produce about 24 billion kilowatt hours of electricity. The actual output rate at Gres 1, however, is substantially lower. Soviet press reports complained that units at this plant have operated at only one-half to two-thirds of capacity during the four years since the initial 500-MW unit went on line.[9]

The USSR is attempting to improve Ekibastuz power plant performance through action on two fronts, coal blending and boiler upgrading. Coal blending would help operations by eliminating boiler breakdowns cause by the arrival of exceptionally poor-quality coal.

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[9] *Pravda*, 8 August 1984, "Lessons of Ekibastuz," p 2.

Blending plants will mix better quality coal with poorer quality coal to assure a predictable, albeit low-quality, boiler fuel.

The boiler upgarding work is aimed at improving equipment so that coal with an ash content of up to 51 percent can be handled without stoppages. This research is, however, still at an early stage according to a September 1984 article in a Soviet power-equipment journal.[10] Given the usual Soviet lags between research and development and introduction on a commercial scale, this new technology may not be available until the mid-1990s. The new technology may not be available until the third or fourth Ekibastuz Gres power plant is built. Alternatively, the Soviets may elect to delay construction of the latter two power stations until they have a boiler technology appropriately matched to the coal being delivered.

C. KANSK-ACHINSK COAL: FORTY PERCENT WATER

Kansk-Achinsk is the largest coal basin in the Soviet Union. according to Soviet coal-industry journals, the basin contains about 600 billion tons of lignite, of which 104 billion tons are stated to be recoverable by surface-mining methods. Because of the basin's enormous reserve base, Soviet energy planners have considered it a major potential source for electric power to the western regions of the USSR.

The high moisture content of Kansk-Achinsk coal (about 40 percent), low heating value (3,300 Kcal/kg), and variable physical and chemical characteristics, however, make its direct shipment by railroad to power plants in the western USSR uneconomical. Kansk-Achinsk coal is subject to spontaneous combustion in storage and transit and tends to freeze together in cold weather, making it difficult to handle.

The USSR decided to step up development of the Kansk-Achinsk basin in the late 1970s. Annual output has increased from 28 million tons in 1975 to about 44 million tons in 1986. The Soviet press reports plans to produce about 70 million tons of lignite from the Kansk-Achinsk basin in 1990 and to crease output to 170–200 million tons per year by 2000. To attain the latter rate of output, the Soviets plan to develop two new surface mines, Bordino 2 and Uryupskiy 1. Eventually they plan to incease annual output from the basin to 350 million tons by developing three additional mines-Berezovskoye 2 and Italskiy 1 and 2.

The low energy content and physical properties of the coal limit the economically effective radius for rail shipment to 1,500 km—400 km short of major demand centers in the Urals and 2,000–3,000 km short of the central regions of the European USSR. Proposed solutions for rapid development of the Kansk-Achinsk basin have involved two general approaches.

The first calls for extracting the energy content of the coal in power plants near the mines and transmitting the electricity to the western USSR over very high-capacity, ultra-high-voltage powerlines.

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[10] *Energomashinostroyeniye*, September 1984, pp 46–47.

The second requires upgrading the coal quality through processing in facilities near the mines and transporting the resulting semicoke, thermocoal, or liquid fuel to the western USSR.

The first approach, which began to be stressed in the mid-1970s, has apparently received the lion's share of attention and funding thus far. According to recent Soviet press reports, the Soviets plan to build two or three large, coal-fired, mine-mouth power plants at Kansk-Achinsk by 1995. Each power plant, which will reportedly be equipped with eight 800-MW units (boiler plus steam-turbine—generator set), could sustain a demand for about 25 million tons of Kansk-Achinsk coal annually. These plants, however, are far behind schedule and are beset with many unresolved problems.

The first plant is currently under construction at Berezovskoye. Construction has been slow and plagued with delays. The 800-MW unit is essentially a prototype unit that has not been field tested. At least two to three years probably will be required to discover and correct problems before the unit can operate satisfactorily. Attempts to burn Kansk-Achinsk coal in a 500-MW boiler at Nazarovo ended in failure. Press reports indicate that the unit was down a total of three years during the first five years of operation.

The construction history at Berezovskoye, the lack of a successful prototype, Soviet press reports alluding to unresolved technical problems, and the fact that the Soviets are now attempting to develop a new type of combustion technology for Kansk-Achinsk coal all strongly suggest that the powerplant may not operate satisfactorily when completed.

V. Development of Synfuel Technology

Although the USSR has conducted coal synfuel research since the early 1950s, the Soviets—like Western energy experts—probably began to view synfuels as a realistic option only in the 1970s. The Soviet coal synfuel effort is directed primarily at the potential for liquefying Kansk-Achinsk coal. The coals at Ekibastuz (too high in ash content) and Kuznetsk (good in quality and needed for other uses) are currently not being viewed by the Soviets as candidates for synfuel projects.

Although liquefaction technology has been successfully developed in the West, this technology has been temporarily shelved due to the currently low price of crude oil relative to the high costs of constructing and operating a liquefaction facility. Western estimates indicate that plants to produce 5 million tons of synthetic liquids per annum would cost about $4.6 billion per plant. The production costs—including capital charges—are estimated at roughly $40-50 barrel.

Earlier Soviet plans called for the large-scale production of either semicoke or thermocoal.[11] In the early 1980s, the USSR completed

[11] In the production of semicoke by pyrolysis, coal is hearted in the absence of air to about 550 degrees Celsius, and some synthetic liquids are produced. In the production of thermocoal, the moisture is simply removed by heating the coal to about 450 degrees Celsius; most of the volatile matter that contributes to better combustion remains. Although no synthetic liquids are produced, the heating value of Kansk-Achinsk coal is increased from about 3,500 kilocalories per kilogram to about 6,400.

construction (begun in 1976) of a commercial-demonstration facility at Krasnoyarsk that uses pyrolysis to process up to 1.2 million tons of Kansk-Achinsk coal per year and produce about 400,000 tons of semicoke, 54,000 tons of synthetic oil, and 120 million cubic meters of gas. Earlier media reports indicated plans to build three large-scale commercial pyrolysis facilities, each with an annual processing capacity of 25–50 million tons (input).

Soviet statements on future synfuel research suggests that the Soviets may be abandoning plans for using pyrolysis on a large scale because the liquid yield is only about 5 percent—which, according to a Soviet technical journal, makes high-volume production of synthetic liquids "practically impossible." The Soviet press reported in 1983 that a scientific committee on synfuels, subordinate to the State Committee on Science and Technology, concluded that pyrolysis cannot be used as a basis for processing Kansk-Achinsk coal into synfuels. The Soviets would still be left with the task of transporting a large volume of the solid product (semicoke) long distances in special, closed railroad cars or covered with an oil-based liquid to prevent absorption of water from rain or snow. There is some evidence to suggest that the semicoke requires high combustion temperatures (which causes the ash content to fuse into slag on the boiler walls) because most of the hydrogen and the volatile matter have been driven off in processing. In addition, Soviet press reports indicated that the semicoke contains a high percentage of nitrgen oxides—suspected to be a major contributor to formation of acid rain.

Analysis of recent press reports, Soviet technical journals, and the Long-Term Energy Program indicate that the USSR believes that direct-conversion (liquefaction) is a better alternative to semicoke and thermocoal. At a mine near Moscow, the Soviets are currently operating a 5-ton-per-day (input) direct-conversion pilot plant—the ST-5 facility. This plant produces 1 ton of synthetic liquids per day. Construction of the plant began in 1981 but was not completed until 1984. The plant reportedly uses an improved version of the Bergius conversion process. The Soviet media report plans to build a 75-ton-per-day (input) liquefaction facility at the Berezovo mine in West Siberia if the process proves feasible.

VI. Ultra-High-Voltage Electricity Transmission

A technical challenge presented in the development of the USSR's eastern coal basins—notably Ekibastuz and Kansk-Achinsk—is the economical transfer of large amounts of coal-derived energy over long distances. Soviet planners view the Ekibastuz energy complex as a source of electricity not only for the reapidly growing demand in Kazakhstan but also for Central Asia, West Siberia, the Urals, and parts of the European USSR. The complex of Ekibastuz powerplants, which will include the five large Gres plants and some smaller plants now on the drawing boards, will have a capacity of nearly 40 million kW and generate 220 billion kilowatt hours (kWh) annually. Consumers in Kazakhstan are scheduled ultimately to receive 100 billion kWh; 80 billion kWh is slated for other areas of Central Asia and parts of West Siberia;

and 40 billion kWh is to be distributed to the Urals and farther West.

Ultra-high-voltage (UHV) electricity transmission provides—in theory—an efficient solution to the energy-transfer problem. Mine-mouth powerplants can be linked via UHV transmission lines to distant consumers, eliminating congestion of rail lines and providing a highly usable form of energy. The UHV transmission systems needed at Kansk-Achinsk and Ekibastuz, however, call for technical development that equals or exceeds that in use anywhere in the world. Current goals call for connecting Ekibastuz with substations in the Urals, using 1,150 kilovolts (kV) alternating current and with Tambov, south of Moscow, using 1,500 kV direct current.

Moscow has given a higher priority to the work on the 1,500 km Ekibastuz-Urals 1,150-kV transmission line because segments can be put into service incrementally. The western section leading to the Urals is under construction and will connect a transformer substation at Ekibastuz with substations at Kokchetav, Kustanany, and Chelyabinsk. According to the Soviet media, the Ekibastuz-Kustanay portion of the line is energized at 500 kV.[12] The entire line, with appropriate transformers and switching equipment for full capacity operation, may not reach Chelyabinsk until the late 1980s.

The 1,500-kV direct-current transmission line is the UHV option that would give the Soviets the capability to move electricity the longest distances. Plans for this line call for transmission of power a distance of 2,414 km from Ekibastuz to Tambov. This line probably will not be fully operational in this century.

VII. Energy Policy Choices and Implications

In addition to the techological obstacles, the need for responding to the growing investment needs of the oil industry will further constrain Moscow's latitude in dealing with coal development. Because there is no substitute for oil in many critical uses, Gorbachev's energy policy will need to ensure adequate oil supplies before it can focus on the longer term role of coal.

To be successful during the remainder of the 1980s and into the 1990s, the strategy of coal resurgence must not only incorporate new technologies but also compete with natural gas and nuclear energy in terms of reliability and economy. The competition for investment resources will be keen as Moscow pursues costly projects in the oil and gas sector: offshore oil development in the Caspian Sea; sour gas development at Astrakhan and Karachaganak; and development of West Siberian gasfields that are located north of Urengoy in more hostile environments.

The Long-Term Energy Program recognizes this competition in its schedule for the development of energy sources. Natural gas has been endorsed as the fuel that is to provide growth in total energy at least through the mid-1990s, when gas output is expected to level off. Coal and, to a lesser extent, nuclear power are scheduled to meet the subsequent growth of total energy demand in the economy, eventually surpassing the contribution of natural gas.

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[12] *Ekonomicheskoye gazeta*, 1985, No 36 p 3.

Natural gas output is growing robustly, and the Soviets are mustering resources to convert facilities from oil and coal fuels to gas so that industrial growth can be maintained. Electricity output at nuclear plants has increased at an average annual rate of nearly 15 percent since 1979, even though nuclear energy expansion continues to be hampered by bottlenecks in construction and component manufacturing and future progress is jeopardized by Chernobyl'.

Backing for investment allocations that would enable coal to become the prime Soviet energy source sometime after the mid-1990s will be hindered by coal's reputation for unreliability. During 1981–85, declining coal quality caused major problems for the electric power and metallurgical industries, the main coal users. Many power plants had to supplement coal firing with oil or natural gas (or substitute these for coal entirely), because the energy value of the coal being supplied to them had dropped. At a large number of power plants, the poor coal quality caused breakdowns of key equipment, forcing the plants to shut down for repairs. In the metallurgical industries, steel production was particularly hard hit by coal shortfalls and quality deterioration. Backers of the coal strategy can argue that new technology in mine-mouth powerplants and, eventually, synfuel development will improve the quality of energy derived from coal. The promised improvements lie in the future, however, while the reliability of natural gas and electricity from nuclear power plants is a present and continuing reality.

FUEL USE AND CONSERVATION IN THE SOVIET UNION: THE TRANSPORTATION SECTOR

By Albina Tretyakova and Barry Kostinsky [1]

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SUMMARY

Soviet success at fulfilling the goals of the current Five Year Plan (1986–90) depends in large part on the ability to conserve raw materials, especially fuels. The Soviet Union is facing stagnating coal and oil production, while domestic and export requirements for fuels continue to grow. The tremendous increase in gas production since the mid-1970's has offset the lack of growth in other fuel sectors, but fuel supplies remain tight. Moreover, the costs of expanding fuel production are enormous. Accordingly, the Soviets are counting on conservation efforts to supply more than half their incremental fuel and energy requirements between 1986 and 1990.

This paper briefly examines the pattern of fuel use in the Soviet Union, concentrating on a major consumer: the transportation industry. This industry accounts for about 13 percent of all Soviet energy use and is the focus of one of the most important energy saving projects, the program to switch Soviet trucking from gasoline to diesel fuel. It also has been an area of both success and failure in past efforts to conserve fuel. Examining this industry provides insights into Soviet prospects for substantial fuel savings in the future.

I. INTRODUCTION

The Soviet Union is second only to the United States in production and use of energy. It is the largest producer of crude oil and natural gas, and it has the world's largest reserves of natural gas and coal.[2] Yet Soviet planners have become increasingly concerned about energy supplies, especially in light of the high costs of finding and extracting ever increasing amounts of fuel.

Traditionally, Soviet planners relied on increased supply—achieved through increased investment—to meet growing fuel

[1] Economists, Center for International Research, Bureau of the Census.
[2] Handbook, 1986, pp. 130–133.

needs. Despite lip service to fuel saving measures, an increasing share of the investment budget was devoted to the fuel industry.[3] Investment in this industry (including the cost of building pipelines) has risen from about 20 percent of the total investment budget in the 1971–75 period to 37 percent in 1981–85.[4] Soviet fuel production expanded very rapidly in the 1960's and into the mid-1970's, supplying the expanding economy with energy. Between 1960 and 1975 fuel output grew over 5 percent annually (based on output in standard units, see table 1), but between 1975 and 1980 it grew only 3.8 percent annually, finally falling to an annual rate of 2.4 in the 1980–85 period. Production of different fuels grew at varying rates, with gas always being the fastest growing and also being the only fuel which has continued to grow rapidly. Thus, an important element of Soviet energy policy up to now has been one of fuel substitution, with natural gas rapidly approaching oil as the primary fuel. The shift to gas is especially striking in the 1980–85 period, when it supplied virtually the entire increase in fuel output.

Soviet fuel exports will not be discussed here, but it should be noted that net energy exports have increased steadily as a portion of total energy supplies, except for the decline in 1985. It is too early to determine whether this is the beginning of a trend.

Overall patterns of fuel consumption have not changed substantially over the years. Data for 1960–80 show important but not dramatic shifts (table 2). Industry and construction have maintained an almost constant proportional claim on fuel resources but increasingly fuel is used by power stations which supply the rest of the economy rather than extensive use of fuel directly by enterprises. Also, the use of fuels as raw materials (e.g. for production of petrochemicals) has grown. The decline in transport's share between 1960 and 1970, is the result of substituting diesel fuel for coal as the main fuel for railroads.

TABLE 1.—USSR: FUEL AND ENERGY RESOURCES, 1960–85

[In million tons, standard fuel units]

	1960	1970	1975	1980	1985
Total fuel and energy resources	836.5	1,399.8	1,845.2	2,157.4	2,465.2
Sources:					
Fuel output	692.8	1,221.8	1,571.3	1,895.6	2,137.3
Oil (including gas condensate)	211.4	502.5	701.9	862.6	851.3
Gas	54.4	233.5	342.9	514.2	759.9
Coal	373.1	432.7	471.8	476.9	486.9
Other fuels	53.9	53.1	54.7	41.9	39.2
Other sources of energy:					
Hydro-electric stations	6.3	15.3	15.5	22.6	26.4
Imports	10.7	14.1	36.5	17.8	31.8
Other	32.7	36.5	42.8	51.8	65.5
From previous year	94.0	112.1	179.1	169.6	204.2

[3] For a more comprehensive examination of Soviet energy policies see Hewett 1986 and 1984.

[4] For details on the rising costs of producing fuels in the Soviet Union see Tretyakova and Heinemeier, 1986 a, b, and c. The information in these reports is used to supplement official investment statistics (*Narkhoz 80*, p. 338; *Narkhoz 85*, p. 368) which show direct investment in the fuel industries but do not report data for pipelines.

TABLE 1.—USSR: FUEL AND ENERGY RESOURCES, 1960–85—Continued

[In million tons, standard fuel units]

	1960	1970	1975	1980	1985
Consumption:					
Current domestic use	678.0	1,117.3	1,412.2	1,665.8	1,915.9
For energy production	221.2	458.2	613.5	745.1	867.4
For other uses	456.8	659.1	798.7	920.7	1,048.5
Exports	59.8	167.6	238.9	321.5	350.2
Carryover to next year	98.7	114.9	194.1	170.1	199.1

Source: Narkhoz 85, pp. 53, 54, 157. (Other fuels includes peat, shale, and firewood.)

TABLE 2.—U.S.S.R.: MAJOR ENERGY CONSUMERS, 1960–80

[Percent of total domestic supply]

	1960	1970	1980
Total	100	100	100
Industry and construction	61	64	61
Power stations	27	32	35
Nonfuel use	1	5	7
Other	35	27	19
Transportation	15	11	13
Agriculture	6	6	7
Housing and communal services	18	19	19

Source: Melyent'yev and Makarov [1983, p. 43] report consumption in standard fuel as well as the shares given here. However, the total domestic consumption figures differ slightly from official data, probably due to variation in computing the fuel equivalence for hydroelectric power. The effect on consumer shares is negligible.

Because of deficiencies in official national income (net material product) data, it is difficult to precisely measure the fuel efficiency of the Soviet economy. A rough measure of fuel efficiency shows some improvement in the past twenty-five years: in 1960, 4.68 tons of fuel and energy were required for each 1000 rubles of national income produced; by 1985 this had declined to 3.32 tons (see table 3).[5] Official Soviet statistical yearbooks now include a number of measures of fuel savings. For 1985, measures taken since 1980 saved 138 million tons (standard fuel, tst), or 7 percent of the amount of fuel consumed.[6]

Over the past 25 years there were three major changes which saved fuel: improved technology in the energy sector, the modernization of the Soviet railroads, and the production of higher quality fuels.

Fuel savings in the energy sector resulted primarily from the expansion of co-generation. This process which utilizes the byproduct heat from power generation greatly increases the fuel efficiency of the power sector.[7] The improvments in fuel utilization in power

[5] Using official Soviet statistics on the growth of national income in constant prices would indicate less improvement in fuel and energy efficiency. Furthermore, a similar measure based on the CIA's estimate of Soviet GNP (in constant prices, Handbook, 1986, p. 35) shows deterioration in the ratio of fuel and energy resources per dollar of GNP.

[6] *Narkhoz 85*, p. 58. Additional data show fuel (excluding motor fuels), electric power and thermal power savings for each year from 1981 to 1985 *(Ibid.)* These savings are reported to reflect growing nuclear power output, better use of secondary energy resources and other "structural factors."

[7] See Campbell, 1980, Chapter 3.

are evident from the lowered heat rate in Soviet power generation, which fell 30 percent between 1960 and 1985 (table 3).

Substantial fuel savings were realized in Soviet rail transport by the substitution of electric and diesel locomotives for coal-fired steam engines. In 1960 coal fueled almost 60 percent of railroad hauling; by 1975 it had virtually disappeard as a railroad fuel. More recently, the subsequent substitution of electricity for diesel fuel has provided fuel savings. It is important to note that the substitution of electricity for diesel fuel not only results in a net fuel savings (even after taking account of the fuel required to generate electricity), but it also allows the Soviets to use gas (or nuclear or hydroelectric) generated power instead of relatively scarcer oil resources.

Throughout the Soviet economy, improved fuel efficiency during this period also resulted from the increased use of high quality fuels. High grade fuels, such as natural gas and petroleums displaced coal, and for most of this period, high quality coal was displacing lignite. The shift to higher quality fuels is evident in the rising proportion of gas and oil in Soviet fuel production. Gas and oil increased from 38.4 percent of total fuel use in 1960 to 75.3 percent in 1985 (table 3).

TABLE 3.—U.S.S.R.: ENERGY INDICATORS, 1960–85

	Energy intensity (ist/1000 rubles of national income)	Heat rate in electricity generation (g/kWh)	Share of gas and oil in total fuel production (percent)
	(1)	(2)	(3)
1960	4.68	468	38.4
1970	3.85	367	60.2
1975	3.89	340	66.5
1980	3.60	328	72.6
1985	3.32	326	75.3

Source and methodology

Col. 1: Based on national income produced (in current prices) and total fuel and energy consumption Narkhoz 85 pp. 36 and 54). Similar measures based on constant price national income (and gross social product) confirm improvement in fuel and energy efficiency. However, energy efficiency computed form the CIA's estimate of Soviet GNP (Handbook, 1986, p. 16) shows a deterioration.

Col. 2: 1960: Narkhoz 67, p. 233; 1970–85: Narkhoz 85, p. 156.

Col. 3: Based on table 1.

The factors that saved fuel over the past 25 years have generally been exhausted. The data in table 3 show greater declines in the earlier years than recently. Some gains will most likely continue in some of these areas (especially further electrification of railroads), but new avenues have to found to continue—and accelerate—fuel conservation in the Soviet Union.

The burden of constantly expanding output to meet needs grew substantially in the 1970's. Costs of extracting coal and oil increased rapidly as the Soviet turned to less accessible reserves.[8] Moreover, older mines and wells were becoming depleted so that an increasing portion of production from new sources was simply replacing lost production rather than increasing supplies. Accordingly, when Soviet planners were compiling the 12th Five Year

[8] Tretyakova and Heinemeier, 1986a, pp. 66 and 100; 1986c pp. 36 and 51.

Plan, they were forced to recognize more than ever before the need to conserve fuel rather than project ever rising production.

II. Fuel Conservation in the Twelfth Five Year Plan

Soviet economists recognized the burden placed on the economy by expanding fuel requirements and the investment required to satisfy them.[9] Accordingly, Soviet planners shifted their emphasis in the 12th Five Year Plan (1986–90). Most additional raw material requirements are to be satisfied by conservation rather than expanded production: plans call for 75–80 percent of the otherwise incremental raw material inputs to be met by conservation measures;[10] 51 percent of fuel and energy requirements are to be met by conservation and substitution.[11] If successful this would mean that fuel production would have to increase annually by about 10 percent (200 million tst) instead of 20 percent.

Accordingly, the current plan looks to new areas of conservation and fuel substitution to save precious fuel resources. The greatest single source of fuel savings in the plan is the increased reliance on nuclear power. Between 1986 and 1990 increased dependence on nuclear power is to save 70 million tst of fuel, or 35–40 percent of all anticipated savings. The introduction of new, more fuel efficient equipment is to be the second most important source of savings. Table 4 lists the planned source of savings and the volume of savings expected in the current Five Year Plan.

TABLE 4.—U.S.S.R.: PLANNED FUEL SAVINGS, 1986–90

[Million tons, standard fuel units]

	Volume	
	Low estimate	High estimate
Total savings	200	230
Measure to save fuel:		
Increasing nuclear power	70	90
Introducing new, more energy efficient equipment	66	70
Increasing efficiency and reducing losses in transportation	25	28
Replacing obsolete equipment	20	21
Reclaiming heat and wastes	13	14
Other	6	7

Source: Total expected savings and those from nuclear power are reported in Pravda, Nov. 9, 1985, p. 3. The remaining categories are calculated on the basis of proportions given in Dykhno, 1982, p. 3.

Analyzing Soviet prospects for achieving these goals is difficult partly because we lack adequate information on fuel use in the Soviet Union. There is little detailed, systematic data on patterns of fuel consumption among productive users or even between productive and non-productive consumers. However, several western authors have estimated more detailed fuel and energy balances for the U.S.S.R.,[12] and we are currently conducting a comprehensive

[9] For example see Beschinskiy, 1982, pp. 29–30.
[10] "Osnovnyye," 1985, pp. 1–6.
[11] Vorozheykin, 1986, p. 2.
[12] See, for example, Campbell, 1983 and 1978; Kurtzweg and Tretyakova, 1982.

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review of fuel consumption in the Soviet Union.[13] This paper will concentrate on the work that has been completed on the transportation sector, but will summarize more general trends. Our emphasis on transportation is warranted not only because it is a major fuel consumer but also because it serves as a case study of Soviet efforts to conserve fuel. The transportation sector demonstrates both successes and failures in Soviet energy policy. Finally, it is also the target of one of the major fuel savings programs, the switch from gasoline to diesel fuel in the Soviet trucking fleet.

While transportation is a major fuel consumer, the combined industrial branches (including construction) clearly dominate the Soviet fuel balance (see table 2), accounting for over 60 percent of domestic consumption. The remaining major categories of users include housing (including the municipal economy) just under 20 percent and agriculture (about 7 percent).

Efforts to save fuel in industry are reflected in the goals to improve technology and replace obsolete equipment (table 4). While it is difficult to quantify, the Soviet Union is less fuel efficient in industrial activity than the United States. While U.S. industry is substantially larger than the comparable Soviet sector, each uses approximately the same amount of fuel and energy. Furthermore, the Soviets acknowledge that they are not improving the fuel efficiency of their economy as rapidly as other developed countries.[14] The problem, addressed by the Soviets in their plans, is the generally low level of technology throughout Soviet industry compared with the United States or other western countries and the continued use of obsolete equipment.[15] The plan to modernize the Soviet economy is driven by much more than the need to save fuel or other resources, but the planners are clearly counting on these savings to accompany the modernization process.

The principal consumers of energy within the industrial sector are: ferrous metallurgy (about one-third of fuel and energy consumption within industry), the chemical/petrochemical industry (including oil refining over a quarter), and construction materials (about one-sixth).[16] Therefore conservation efforts most likely will be directed toward these sectors.

Conservation of energy in metallurgy is expected mostly from the reduction of coke consumption for pig iron production and the substitution of basic oxygen convertors for open-hearth furnaces in the steel industry.[17] The Soviets are implementing a series of programs designed to conserve coke (which is in short supply and costly to produce) by substituting other energy sources, mainly electricity and gas, and updating their technology at all stages of pig iron production. The current plan states that output of finished rolled stock is to increase without an increase in pig iron production and with a "considerable reduction of coke consumption."

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[13] The Center for International Research (Bureau of the Census) is currently studying the fuel consuming sectors of the Soviet economy, estimating annual use and evaluating conservation plans. The results of this research will be issued as a series of staff papers.

[14] *Planovoye khozyaystvo*, no. 9, 1985, p. 126.

[15] Pokrovskiy, 1982, pp. 66 and 70.

[16] The shares for separate industries given in this paper are average estimates for recent years and necessarily approximate. More precise data are not available.

[17] Sagers and Tretyakova, 1987. This report will cover fuel and energy consumption in the metallurgical industry.

The plan also calls for a 30–40 percent increase in the output of steel by oxygen converter and electric production technologies. The effect of this shift from open-hearth furnaces on fuel consumption is unclear since electric steel is highly energy intensive, although it does permit the use of relatively more abundant fuels rather than coke.

We do not anticipate substantial fuel savings in the metallurgy industry. Savings in this sector of the economy would be greater if the Soviets were able to reduce the amount of metal used in the rest of the economy, which is also a goal of the current plan.

Conservation of energy in the chemical and petrochemical industry is expected to result from enlarging the size of production units to increase productivity.[18] In general, the introduction of new equipment, including units combining production processes, and the introduction of new catalysts are expected to improve fuel and energy efficiency. However, an important counteracting trend in petrochemicals is the Soviet move toward deeper refining (especially catalytic cracking and hydro-treating) to produce the lighter, more advanced oil products required in a modern economy.[19] These processes reduce the final output per unit of crude input and therefore do not conserve fuel. However, they do result in production of the higher quality fuels that help improve efficiency in other branches, especially transportation.

In the construction materials sector fuel savings are planned from the implemenation of the "dry" method of cement production. Plans call for increasing production by this method to account for 18 percent of cement output in 1985 and 22 percent in 1990,[20] compared with 10 percent in the early 1980's.[21]

The technologies required to implement the changes listed above, as well as other planned improvements, are not new and many have already been introduced in Soviet industry. One Soviet writer estimates that 75 percent of energy savings planned to result from the introduction of new technology is expected from available technology.[22] The challenge is to disperse these newer technologies more widely. The remaining fuel savings will depend on further research and development or on imported equipment. Among the production techniques that the Soviets hope to implement that are not yet introduced are: the use of increased gas temperatures in blast furnaces before blowing (ferrous metallurgy), autogenous smelting of heavy non-ferrous metals and the one-step isoprene production process in petrochemical industry.[23]

As indicated above (table 4), most fuel savings are expected to result from modernization. The only measures explicitly aimed at conserving of energy are secondary heat recapture and secondary fuel (mostly waste gases) utilization. However, planned savings from these measures would amount to only 10 percent of the total expected savings.

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[18] Dobrokhotov et al., 1983, p. 56.

[19] See Sagers and Tretyakova, 1985 for a detailed discussion of the Soviet refining industry and the shift toward secondary processing.

[20] Lyakutkin, 1985, p. 2.

[21] Baubakova and Tyurin, 1982, p. 20; Tsement, 1982, p. 1.

[22] Arakelov, 1985, p. 5.

[23] *Ibid.*

Before going on to discuss the transportation sector, we should mention that we see no major opportunities for fuel conservation in agriculture and housing. Soviet plans call for various improvements in agricultural operations that directly or indirectly would improve fuel efficiency (such as more effective use of tractors by supplying appropriate supplementary equipment and not using tractors for hauling produce) but even if there is a marginal improvement in fuel efficiency the planned increase in the number of tractors will require a greater allocation of fuel for agriculture.

Numerous Soviet authors discuss inefficient fuel consumption practices in housing and the municipal economy, some claiming that as much as half the fuel used is wasted.[24] They call for numerous measures, most notably more insulation, better construction, greater reliance on centralized heating systems, and better management of fuel consuming services through more extensive and careful measuring and metering. Thus far there is no evidence of the improved construction techniques or other practices required to raise the fuel efficiency of Soviet housing and we do not expect any substantial improvement in this area.

The saving of fuel by transport is one of the most important conservation programs. While transportation accounts for only about one-sixth of all fuel and energy use in the Soviet Union, conservation efforts there are critical to the success of the fuel conservation program because they are directed specifically at saving the most precious fuel: oil. One goal of the fuel conservation program is to save oil in some areas by conservation or substitution in order to make it available in other areas. The transportation sector is in both areas. Truck and automobile transport are the primary prospective claimants for oil products; in these cases there is no practical substitute for oil-based fuels. Therefore efforts here are directed at conservation through improved fuel efficiency. At the same time, substantial oil conservation has resulted from the substitution of electricity for diesel fuel in Soviet railroads.

The transportation sector provides an ideal focus for analyzing Soviet conservation efforts both because it is a major player and because it points out both the strengths and weaknesses of the Soviet economy as it moves from extensive to intensive answers to its economic problems.

III. Fuel Use and Conservation in Soviet Transportation[25]

The transportation sector consumes about 31 percent of Soviet liquid fuel production (see table 5). But this understates the importance of transport which is the country's largest consumer of gasoline, diesel fuel and jet fuel.

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[24] See, for example, Roytman and Shreyber, 1987, pp. 30–31 and Kuybyshev and Velikovskaya, 1986, pp. 16–18.

[25] In this section the transportation sector is defined to include farm trucks and the fishing fleet but not pipelines. Also, our analysis is primarily of liquid fuels because this is the area of concern for conservation. Electricity use in Soviet railroads is not counted. Our estimate of total fuel use in 1980, excluding the fishing fleet (150 million tst), plus gas and electricity used in pipelines (50 million tst) and electricity used by railroads (20 million tst) combine to the 220 million tst, which is the volume of usage reported in Melent'yev and Makarov (1983, p. 43). The more common Soviet definition of transportation excludes the fishing fleet and private automobiles.

Table 6 summarizes fuel consumption (in standard fuel units) by transport mode. Motor vehicles dominate the pattern of fuel use in the transportation sector (60 percent of total consumption in 1984), with trucks being the most important component of the motor vehicle fleet (38 percent of fuel use in 1984).

The fuel consumption rates in table 6 (based on total passenger and freight turnover) show the variation in efficiency among different type of transport. These differences are important, because attempts to hold down fuel consumption will be partly confounded by the shift to relatively less efficient modes of transportation. Even if each type of transportation becomes more fuel efficient, the shift to more cars and greater use of trucks will increase Soviet fuel requirements.

TABLE 5.—U.S.S.R.: CONSUMPTION OF LIQUID FUELS IN TRANSPORTATION, 1970 AND 1980

Type of Fuel	Consumption (million tons)		Share of available supply (percent)	
	1970	1984	1970	1984
Total	68.3	110.8	33.6	31.0
Gasoline	33.2	52.3	73.7	72.0
Diesel fuel	19.6	35.1	38.2	39.3
Jet fuel	7.0	14.8	37.6	44.8
Mazut	8.5	8.6	9.6	5.3

Source: Tretyakova and Kostinsky, (forthcoming).

TABLE 6.—U.S.S.R.: FUEL CONSUMPTION BY TRANSPORTATION MODE, 1970–84

	1970			1975		
	Fuel consumption (1,000 tst)	Turnover (billion ton-km)	Fuel rate (grams per unit)	Fuel consumption (1,000 tst)	Turnover (billion ton-km)	Fuel rate (grams per unit)
	(1)	(2)	(3)	(4)	(5)	(6)
Total	98,313	2,773	35	133,224	3,665	36
Railroad	16,100	1,323	12	16,870	1,704	10
Marine	7,988	658	12	9,084	738	12
River	3,206	179	18	3,357	228	15
Fishing fleet	6,397	36	177	7,712	47	166
Motor vehicles	54,274	497	109	80,355	823	98
Trucks	44,658	221	202	58,571	338	173
Common-carrier trucks	9,876	64	154	12,393	97	128
Other trucks	34,782	157	222	46,178	241	192
Common-carrier buses	4,384	203	22	6,495	304	21
Other buses	858	39	22	1,600	73	22
Taxis and public cars	2,418	12	202	7,149	36	201
Private cars	1,950	23	86	6,540	73	90
Air transport	10,344	80	129	15,846	125	127
	1980			1984		
Total	155,692	4,218	37	159,188	4,439	36
Railroad	18,341	1,705	11	17,992	1,629	11
Marine	9,568	851	11	9,730	936	10
River	3,265	251	13	3,162	270	12
Fishing fleet	7,937	53	149	9,426	70	135
Motor vehicles	96,878	1,194	80	97,193	1,347	72
Trucks	64,352	432	144	60,775	475	128
Common-carrier trucks	14,939	131	106	13,415	138	97

TABLE 6.—U.S.S.R.: FUEL CONSUMPTION BY TRANSPORTATION MODE, 1970–84—Continued

	1980			1984		
	Fuel consumption (1,000 tst)	Turnover (billion ton-km)	Fuel rate (grams per unit)	Fuel consumption (1,000 tst)	Turnover (billion ton-km)	Fuel rate (grams per unit)
	(1)	(2)	(3)	(4)	(5)	(6)
Other trucks	49,413	301	161	47,360	337	140
Common-carrier buses	8,160	390	21	9,085	434	21
Other buses	2,830	129	22	3,019	137	22
Taxis and public cars	8,308	41	201	6,635	33	202
Private cars	13,228	164	80	17,679	268	66
Air transport	19,703	164	120	21,685	187	116

Turnover consists of both passenger and freight turnover. See Narkhoz 75, p. 798. The figures for private cars are Soviet estimates and may not be reliable.

Source: Tretyakova and Kostinsky, (forthcoming)

The remainder of this section discusses the separate modes of transportation and the factors determining levels of fuel use. The trucking industry which is the most important target for fuel conservation is covered in the final section, which evaluates the dieselization program.

RAILROADS

Railroad transport has traditionally used three types of fuel—coal, mazut, and diesel fuel—as well as electricity. In the 1960's substantial fuel savings resulted from the large scale shift from coal to diesel fuel and electricity. By 1970 coal fired steam engines were an insignificant component of the Soviet rail system, while diesel fuel and electricity were about equal. Since then there has been a steady shift towards electricity. The latter is a more efficient power source but more importantly the shift results in savings of refined oil output. By 1985, 60 percent of freight was hauled by electrical engines.

The 12th FYP calls for further electrification of railroad transport. In addition to the existing 47,500 kilometers of electrified line, 8 thousand kilometers of railroad lines will be switched into electricity. This should save nearly 4 million tons of diesel fuel annually.

Other measures suggested in the plan for saving fuel include improvement and modernization of diesel and electrical railroad engines, installation of better bearings on passenger cars, and general improvements in operations.[26] However, a recent analysis of rail transport indicates that overloading and continued use of old equipment is lowering fuel efficiency.[27]

WATER TRANSPORT

Water transport (marine, river, and the fishing fleet), consumed 22.3 million tons (tst) of fuel in 1984, about 14 percent of total consumption in transportation (table 6). Although water transport accounts for most of the mazut used in all transportation modes (75

[26] Chulkov, 1985, pp. 183–184.
[27] Chulkov, 1985, pp. 183–184.

percent in 1985), diesel fuel is the more important fuel in water transport. Diesel fuel is the major fuel in both the fishing fleet and river transport (92.4 percent and 80 percent, respectively in 1984), while mazut accounts for 74 percent of fuel consumption in marine transport.[28]

There appears to no program specifically aimed at saving fuel in water transportation. Rather, plans call for a shift towards mazut and away from diesel fuel,[29] but it is not clear whether this can be considered a conservation effort. Mazut is a less efficient fuel than diesel, but it is used in the larger ships that are capable of hauling larger loads which saves fuel.[30] Thus, no fuel conservation can be expected in water transport unless substantial investment is made in producing larger ships with more efficient engines.

AIR TRANSPORT

Air transport used 21.7 million tons (tst) in 1984 (table 6), mostly jet fuel. Except for an effort to produce larger jet engines to power planes, the Soviets have not announced any plans to switch or improve fuel use in aviation.

MOTOR VEHICLES

The largest consumer of refined oil products is motor vehicle transport, which accounts for over 60 percent of all fuel used by transportation in 1984 (table 6). Among motor vehicles, trucks account for almost 63 percent of fuel usage and passenger vehicles for 37 percent. Because of the importance of trucks in fuel conservation, one of the components of Soviet fuel policy is the switching of their truck fleet from gasoline to diesel fuel. The dieselization program is discussed in the final section of this report.

Despite the crucial role of trucks, private cars are becoming increasingly important in the Soviet fuel balance. Between 1970 and 1984, private cars rose from 2 percent to 11 percent of the total fuel consumption in transportation (table 6). Furthermore, the number of private cars is planned to reach 16 million units in 1990, compared with 12.5 million units in 1985.[31] Continued improvements in fuel quality will offset some of the effect of this rise, but private cars will certainly claim a larger share of future fuel supplies.

Most passenger vehicles (buses, taxis, and private automobiles) use gasoline; only a few Hungarian-built "Ikarus" buses and a

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[28] Somov, 1983, p. 9

[29] *Ibid.* According to Somov, the share of diesel fuel in each water mode was to decline between 1980 and 1985:

[Percent of total fuel use]

	1980	1985 (planned)
Fishing fleet	92.4	88.9
River	80.0	75.0
Marine	26.0	22.0

[30] According to Soviet estimates, a five percent increase in carrying capacity results in 1 percent fuel saving [Arakelov et al., 1983a, p. 69].

[31] "Lichnyy," 1985, p. 103; *Izvestiya*, 1985, p. 3.

small number of domestically produced buses operate on diesel fuel. Fuel savings in passenger transport in the past have resulted mainly from improved fuel quality and better engines. Improvement in fuel quality—the shift to higher octane gasoline—is largely completed, and further fuel savings in passenger transportation will depend on producing bigger, diesel fueled buses and more fuel efficient automobile engines.

IV. Trucking and the Dieselization Program

The Soviet truck fleet consists of about 9 million trucks, with about 800,000 units being added annually. Traditionally gasoline was the primary fuel used in trucking, but after a major program to shift to diesel trucks over half of truck freight is now hauled in diesel trucks (see table 7). Overall trucking uses about 61 million tons (tst) of fuel, but because diesel is more efficient gasoline accounts for two-thirds of fuel consumption.

Information on fuel consumption in the trucking industry is scarce, so it was necessary to compile extensive data on the various factors determining level of usage.[32] Table 7 summarizes the results and includes projected fuel consumption in 1990.

Fuel use in Soviet trucking reflects the following factors:

—shipping volume as measured by total freight turnover in ton-km;
—structure (mix) of truck sizes in the Soviet fleet;
—organization of trucking industry: the proportion of freight hauled in common carriers;
—type of fuel: gasoline or diesel; and
—fuel quality.

All but the first of these are subject to measures that can and have improved fuel efficiency in the truck fleet.

[32] Details on the derivation of these estimates are given in Tretyakova and Kostinsky, (forthcoming).

TABLE 7.—USSR: CONSUMPTION OF MOTOR FUEL BY TRUCK TRANSPORTATION, 1970–90

Year	Freight turnover (billion ton-km)			Fuel consumption (million tons)			Fuel consumption rate (grams per ton-km)			Fuel consumption (million tst)		
	All engines	Gas engines	Diesel engines	All engines	Gas engines	Diesel engines	All engines	Gas engines	Diesel engines	All engines	Gas engines	Diesel engines
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1970	220.8	177.3	43.5	30.1	26.9	3.2	136.2	151.8	72.8	44.7	40.1	4.6
1975	337.9	257.8	80.1	39.5	34.3	5.2	116.7	132.9	64.8	58.6	51.0	7.5
1980	432.1	274.5	157.6	43.4	34.6	8.9	96.9	126.0	56.2	64.4	51.5	12.8
1985	476.2	225.3	250.9	39.3	26.1	13.3	82.6	115.8	52.8	58.1	38.9	19.2
1990 (plan)	564.3	220.9	343.4	40.2	23.3	16.9	71.3	105.5	49.3	59.3	34.7	24.5

Km = Kilometer.
Tst = Ton standard fuel.

Source: Tretyakoya and Kostinsky, (forthcoming)

Of the factors listed, it is possible to quantify the fuel savings due to substitution of diesel fuel for gasoline, improved fuel quality, and the increased use of common carriers (million tst):[33]

	Total fuel consumption	Annual savings compared with 5 years earlier			
		Total	Source		
			Diesel/gas substitution	Fuel quality [34]	Common carrier
Year:					
1975	39.45	6.51	2.01	4.99	−.05
1980	43.43	8.68	3.05	5.69	.23
1985	39.34	7.04	4.71	2.09	−.07
1990 (plan)	40.22	5.27	2.60	2.16	.31

These data demonstrate that substantial fuel savings are possible from improving the factors determining levels of fuel use. And as the plan data indicate, the Soviets expect continued improvements in the current plan.

We believe that the planned targets for continued fuel conservation in trucking are attainable, but these targets have been scaled back from earlier calls for more massive savings. It appears that the greatest savings have already been accomplished for the remainder of this decade no major advances are likely.

Improved fuel quality—primarily the shift to higher octane gasoline and cleaner diesel fuel—was largely accomplished in the 1970's. Further improvements are likely to minor; the savings indicated above after 1980 are probably the result of many factors affecting fuel efficiency, without none playing a dominant role.

The most dramatic shift to diesel trucks was achieved with the completion of KamAZ and will now proceed on a regular schedule but without providing the substantial additional savings seen in the late-1970's.

In the remainder of this section we examine the factors determining overall fuel requirements in order to estimate current and past levels of fuel use and to evaluate Soviet plans for continued improvements.

SHIPPING VOLUME

Freight turnover, the basic indicator of shipping volume in physical units, is the primary determinant of motor fuel consumption by truck transport. Truck freight turnover more than doubled from 1970 to 1982, increasing from 221 to 485 billion ton-km, before drop-

[33] Tretyakova and Kostinsky, (forthcoming). Savings are estimated by holding conditions constant from 5 years prior to the given year, assuming turnover of the latter year. The overall figures include factors that cannot be separately estimated as well as the three separately identified ones.

[34] In this calculation fuel quality is measured by the fuel consumption rate (tst per ton-km). Therefore it takes account of all factors that have improved fuel efficiency in trucking. While fuel quality is the major factor others include the condition of Soviet trucks (age, state of repair) and road conditions.

ping to 476 billion in 1985 [35] (see table 7). Current plans call for a 18–19 percent increase in truck freight by 1990.[36]

Past and planned growth in trucking reflects the advantages of this mode of transport: faster service and more convenient door-to-door delivery, and less time and money wasted in loading and unloading operations.

Despite these advantages trucking has not and isn't likely to become a major mode of long-distance transport. The average length of Soviet truck hauls increased only slightly between 1970 and 1985, from 15 to 18.5 km.[37] Trucking remains primarily an intra-city mode of transport.

FUEL QUALITY

Between 1970 and 1980 improved fuel quality was the primary reason fuel requirements for trucks rose only about one-third while freight shipments almost doubled.

Gasoline quality improved as octane levels were raised. Higher octane fuels are more powerful and more efficient.[38] In 1970, about half the gasoline used in trucking was the lowest octane (A–66).[39] But by 1978, production of A–66 was phased out,[40] and now most trucks run on a medium octane gasoline (A–76). High octane gasoline (AI–93) is used mostly by cars.

Diesel fuel quality also has improved since 1970 as indicated by its lower sulfur content. Between 1970 and 1980 production of high-quality diesel fuel (sulphur content less than 0.15 percent) increased significantly.

These improvements in fuel quality were accomplished through refining processes (catalytic reforming and hydro-treating) that require relatively larger amounts of crude oil. While there appears to be a net gain when the improved fuel quality is measured against the greater crude input required, further gains will depend on the Soviets ability to introduce more sophisticated (and expensive) refining techniques such as catalytic cracking and hydrocracking.[41]

COMMON AND OTHER CARRIERS

Soviet trucks are operated either by specialized trucking organizations (under the jurisdiction of motor transportation ministries of each republic)[42] or by individual enterprises which purchase and operate their own truck fleets. The trucking organizations are common carriers, available for meeting any shipping requirements. Other carriers tend to be used only to meet the needs of particular enterprise or ministry.

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[35] The drop in freight volume may reflect a slowing of the economy or may be the result of a crackdown on falsification of statistics. Overstating freight hauls has been a common and frequently decried practice which Gorbachev has specifically attacked [see Decree, 1984].

[36] "Osnovnyye," 1985, p.4

[37] *Narkhoz 85*, p. 336.

[38] Azyyev et al., 1985, p. 5

[39] Fedorov, 1976, p. 33

[40] Yudayev, 1980, p. 4.

[41] See Sagers and Tretyakova, 1985 for a discussion of the Soviet oil refining industry.

[42] There is no national motor transportation ministry.

Because they are larger and better run, common carriers are more fuel efficient than other trucking operations.[43] Furthermore, the difference is striking: common carrier trucks require 87.3 grams of gasoline per ton-km while other carriers require 144.2 grams.[44]

Soviet policy calls for greater reliance on common carriers, but this has been a goal for many years and there has been no major shift in the proportion of freight carried in common carriers (about 30 percent).

To help force a shift to common carriers, they are being given priority deliveries of KamAZ trucks. In fact some of the differential in operating efficiency stems from their having these newer, more efficient trucks and benefitting from the special repair facilities dedicated to maintaining KamAZ trucks. By depriving other enterprises of KamAZ trucks and concentrating large trucks and tractor-trailers in common carriers, the Soviets expect to save 1.2 million tons of motor fuel annually by 1990.

STRUCTURE OF THE TRUCK FLEET

Although we cannot precisely measure its effect, a major factor determining fuel consumption levels is the mix of truck sizes in the Soviet fleet.[45] The "efficiency of truck utilization" has improved greatly as more trucks of appropriate size for Soviet shipping needs have been produced. This improvement was possible because of the completion of the KamAZ truck plant.

In the past, truck capacities did not match the economy's needs. Most trucks were medium-sized, carrying a load of 2 to 5 tons. However, most freight cargos were less than 2 or more than 5 tons. Therefore, most trucks generally either travelled underloaded or required two runs to complete delivery.

Soviet specialists estimate that the most appropriate mix of trucks is about 40 percent for medium trucks and about 30 percent for larger and smaller trucks; this is the so-called "rational" fleet structure. A comparison of the rational structure with actual and recent planned structures (table 8) shows that the Soviet Union is only slowly moving toward the right mix of trucks.

TABLE 8.—U.S.S.R.: STRUCTURE OF THE SOVIET TRUCK FLEET, 1970–85

[In percent]

Truck size	1970	1975	1980 (plan)	1980	1985 (plan)	Rational
	(1)	(2)	(3)	(4)	(5)	(6)
Total	100.0	100.0	100.0	100.0	100.0	100.0
Less than 2 tons	6.0	10.0	14.3	12.3	13.5	29.0
Between 2 and 5 tons	84.0	76.8	64.5	70.4	53.2	41.0

[43] The average common carrier has a fleet of 120 trucks while other carriers have only 17 [Kolyesov, 1981, p. 63]. The more efficient operation of common carriers can be seen in their higher coefficients of utilization [see Vasil'yev et al., 1985, p. 14]. These coefficients indicate the level of usage, that is the degree to which trucks are fully rather than under utilized (for example by making return trips without a load).

[44] Smal', 1985, p. 99. Among other carriers, farm trucks are the least fuel efficient, using 184.6 grams of gasoline per ton-km. See also, Chulkov, 1979, pp. 48–49.

[45] This factor is assumed to be reflected in the fuel consumption rates.

TABLE 8.—U.S.S.R.: STRUCTURE OF THE SOVIET TRUCK FLEET, 1970–85—Continued

[In percent]

Truck size	1970	1975	1980 (plan)	1980	1985 (plan)	Rational
	(1)	(2)	(3)	(4)	(5)	(6)
Greater than 5 tons	10.0	13.2	21.2	17.3	33.3	30.0

Source:
Col. 1: Based on Velikanov, 1981, p. 35 and Afanas'yev (Ed.), 1977, p. 110.
Cols. 2 and 3: Khodosh, 1980, pp. 39–40.
Cols. 4 and 5: Biryukov, 1981, p. 42.
Col. 6: Velikanov, 1981, p. 35.

Through the late 1970's, and especially in the early 1980's, production of large trucks increased substantially, mostly due to the startup of the new gigantic truck plant on the Kama River at Brezhnev (KamAZ). However, the number of small trucks has increased only slightly, from 10 percent of the total in 1975 to 12.3 percent in 1980, still short of the goal of 29 percent. The USSR plans to enlarge its fleet of small trucks with the completion of the Korovobad truck plant, now under construction.[46]

Despite the slow prograss in producing adequate numbers of small trucks, KamAZ and other large trucks have reduced the imbalances in the truck fleet and improved fuel efficiency.

THE DIESELIZATION PROGRAM

Between 1975 and 1980 most fuel conservation in trucking resulted from greater reliance on diesel fuel. This shift from gasoline to diesel fuel continues and is the most promising source of continued fuel savings. Although, diesel engines are 25–30 percent more fuel efficient than gasoline-powered internal combustion engines,[47] only about 20 percent of Soviet trucks are diesel.[48] Moreover, the shift to diesel fuel is occurring only gradually, primarily reflecting the integration of KamAZ trucks into the fleet. However, Soviet plans call for continued dieselization of the trucking industry.

The current FYP calls for 60 percent of truck freight to be hauled in diesel trucks by 1990,[49] compared with 52 percent in 1985 and only 36 percent as recently as 1980.[50] The 1990 target represents a considerably scaled back goal from earlier expectations and plans. Earler plans called for as much as 85 percent of freight turnover to be carried in diesel trucks.[51] As a program that has been moderately successful while not reaching expected goals and increasingly suffering from more general problems plaguing the Soviet economy, the dieselization program is a good example of conservation efforts.

Calls for switching to diesel fuel go back to the mid-1960's, when various transportation research organizations began to consider the advantages of dieselization. Most suggested multi-stage 15-year pro-

[46] Popov, 1986, p. 2.
[47] See Chulkov, 1979, p. 45 and Yenikopolov, 1983, p. 32.
[48] According to Shatrov and Korol'kov, [1983, p. 2] in 1980, only 14 percent were powered by diesel engines: 20 percent of all trucks, 10 percent of buses, and none of the passenger cars.
[49] Osnovnyye," 1985, p. 2.
[50] See Chulkov, 1985, p. 50; "Dizelizatsiya," 1985, p. 2, and Biryukov, 1981, p. 42.
[51] "Diezelizatsiya," 1985, p. 2.

grams for converting first trucks (especially heavy trucks) then buses and finally cars to diesel fuel. These plans were generally more ambitious than current expectations, which apparently recognize some of the obstacles to widespread dieselization.

Past failures to achieve wider use of diesel fuel were primarily the result of the inability of the Soviet machinebuilding industry to gear up for mass production of diesel trucks. There have also been some problems with ensuring production of adequate amounts of diesel fuel.[52]

Almost three-quarters of the total cost of the dieselization program is investment in the machinebuilding industry.[53] This has gone into the KamAZ truck plant (which relied heavily on imported equipment, another sign of the inadequacy of the domestic industry[54] as well as modernization and expansion of older truck-building facilities such as GAZ and ZIL.

The GAZ and ZIL enterprises, both of which date from the 1930's, still produce about half of all Soviet trucks, all gasoline powered. Current plans call for expanding both GAZ and ZIL production lines, to include diesel engines and trucks.[55] Although production of some diesel engines is scheduled to begin in 1988[56] we do not expect these plants to make a substantial contribution to the dieselization program until well into the 1990's.

For the present, the KamAZ truck plant is providing 150,000 new diesel trucks and 250,000 diesel engines annually—enough to make it fairly certain that the Soviet Union will be able to achieve the goal of shipping 60 percent of truck freight in diesel trucks by 1990. If the target is not reached it will probably be the result of other factors such as inadequate repair and maintenance facilities rather than a shortfall in production.

However, the road to ensuring adequate production of diesel trucks was long: planning and building the KamAZ complex took 15 years, including 10 years from initial production (5,000 trucks in 1976) to reaching full capacity in 1985. Also, as indicated, completion of this project depended on extensive use of imported equipment.

Traditionally, the Soviet Union has relied on gasoline engines for motor vehicle use, in part because diesel truck engines are more expensive to produce. Diesel production was concentrated on heavy, low-speed engines for powering electrical generators, railroad locomotives and ships, as well as heavy engines for tractors and heavy-duty off-highway trucks. Diesel engines for trucks require more precise tooling and must be of consistently higher quality than those used for locomotives, ships, and tractors.[57] Initial plans call-

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[52] For a detailed discussion of the problems in the Soviet oil industry see Sagers and Tretyakova, 1985.

[53] Chulkov, 1985, p. 2.

[54] According to Bogomolov [1986, p. 359], 70-80 percent of the equipment in KamAZ is imported.

[55] ZIL is building a plant in Yartsevo to produce diesel engines that will replace the gasoline engines currently used in ZIL-130 and ZIL-375 trucks. The GAZ plant is scheduled for a major expansion to produce a new medium-sized diesel truck designed to haul trailers [Shugurov, 1986a, p. 2].

[56] "Kurs," 1984, pp. 6-7.

[57] "Diesel engines are 50 percent more labor intensive than gasoline engines. The requirements for precision in their manufacture are much more stringent, as are those for the quality

ing for the mass production of diesel trucks could not be met because they did not allow sufficient lead time to retool and expand the motor- and truck-building industries. In particular, they did not provide time to produce the more sophisticated machinery and to train the labor required for diesel engine production.

Despite the success of KamAZ and the prospects for meeting current goals for dieselization, more widespread use of diesel trucks cannot proceed unless the major class of trucks in the Soviet Union, the medium-sized GAZs and ZILs, can be equipped with diesel engines. Expanding dieselization to the rest of the truck fleet will be difficult. Both KamAZ and Avtodizel are geared to produce only large diesel engines; neither is capable of producing the medium engines required for wide-scale dieselization of the Soviet truck fleet.[58]

The expansion of dieselization beyond large trucks is limited by Soviet lack of experience in producing medium- and small-sized diesel engines, which require much more precise tooling work and more skilled labor than large diesel engines. At the current time, there are no plants for production of medium engines, although construction has started on several projects. One is the expansion of the Kutaisi plant, where plans call for the production of 20,000 diesel trucks per year for agricultural use. Another is the addition of a ship at the Tutayevkiy plant (located near Yaroslavl) to produce and repair diesel engines. The Kustanay diesel engine plant, which heretofore had produced only heavy diesel engines for caterpillar-type tractors, is being equipped to manufacture 6-, 8-, 10-, and 12-cylinder diesel engines, based on a license from the West German firm of "Klockner-Humbolt-Deutch" for UralAZ and other truck plants.[59] Also, as indicated above, plans call for ZIL and GAZ to begin their own production of diesel engines for medium-size trucks.

In addition to medium-sized diesel engines, the Soviets plan to produce small diesel trucks and engines. The UAZ association plans to construct a subsidiary truck-building plant in Kirovabad to build small diesel trucks and engines. There is also a Soviet diesel engine developed for cars (VAZ-341), but it has not yet gone into production.[60]

As with most large programs, successful dieselization will also depend on many other less directly related factors. Impediments to greater reliance on diesel motor vehicles include: inadequate production of the heavy-duty batteries and starters required for diesel vehicles, poor roads, and grossiy inadequate repair and maintenance facilities. The last is currently being widely cited in Soviet literature questioning why the KamAZ trucks are not fulfilling their promised levels of performance.[61] These problems illustrate

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of the materials of which they are made and completed" [Bashindzhagyan, 1985, p. 2]. Also diesel engines are 25 percent heavier and require 15 percent more metal than comparable gas-powered engines ["Kak v'yehat'," 1985, p. 15 and Chulkov, 1979, p. 46].

[58] At the present time, the only GAZ and ZIL models equipped with Avtodizel and KamAZ engines are large trucks.

[59] Shugurov, 1986a, p. 1.

[60] Shugurov, 1986a, p. 2.

[61] See, for example, Syedov, 1984, p. 17.

that fuel conservation programs face many obstacles beyond the initial technological problems of implementation.

It is clear that Soviet planners continue to move toward further dieselization. However, past experience (such as the 15-year gestation period for KamAZ) suggests that the expansion of diesel engines into the medium and small end of the Soviet motor vehicle fleet will not be rapid. It will be well into the 1990's before current projects begin to help in the conservation of Soviet fuel resources.

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COMMENTARY

By Jochen Bethkenhagen*

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INTRODUCTION

While in the articles in this section the authors are concentrating on specific fuels, on electricity or conservation, this analysis focuses upon total energy production trends. Taking into consideration the results of the 27th Party Congress and of the 12th Five-Year Plan adopted in June 1986, this commentary considers if and which changes in energy production and in the fuel mix are developing. In this context it will have to be assessed in particular whether there is a transition from a supply- to a demand-oriented policy and whether oil will be partially replaced by other forms of primary energy (coal, gas, nuclear) within the next few years.

ENERGY PRODUCTION UNDER THE 11TH FIVE-YEAR PLAN (1981–85)

The results of the energy sector have by no means been encouraging during the 1981–85 Five-Year Plan.[1] The production targets were clearly missed for all energy sources, except for natural gas where output exceeded the target.

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Most of this article is drawn from a paper which was presented by the author at a NATO-Colloquium which was held from April 1 to April 3, 1987 in Brussels.

[1] See 1985 plan fulfilment report dated 26 January 1986.

TABLE 1.—PRODUCTION OF PRIMARY ENERGY IN THE SOVIET UNION, TARGET OF THE 5-YEAR PLAN, AND ACTUAL OUTPUT IN 1985

	Unit	Target	Actual	Difference	Actual output in percent of target
Coal (net)	Mn tons	700	648	Less 52	92.6
Crude oil	Mn tons	630	595	Less 35	94.4
Natural Gas	Bn m^3	630	643	Plus 13	102.1
Nuclear Energy	Bn kWh	220	167	Less 53	75.9
Hydropower	Bn kWh	230	215	Less 15	93.5
Total [1]	Mn tons of coal equivalent.	2.323	2.232	Less 91	[illegible]1

[1] Including wood, peat, and slate.

The importance of natural gas in the generation of primary energy increased further. Its contribution to the total output from domestic resources rose from approximately one quarter to one third. Although the nuclear energy proportion doubled to 2.5 percent, it remained insignificant in international comparison. Crude oil and coal lost importance although, with a proportion of 38 percent, oil continued to be the most important energy source of the Soviet Union.

The power station capacity, approx. 29,000 MW installed by late 1985, clearly remained below the target of 39,000 MW, i.e. by approximately one quarter, which caused the Chairman of the Council of Ministers of the USSR, N.I. Ryzhkov, to utter straightforward criticism on the occasion of the 27th Party Congress of the CPSU: "In the course of the 11th Five-Year Plan period the USSR Ministry of the Power Industry fell short of its targets in starting up nuclear power plants, which created an additional demand for fossil fuels. Taking into account our country's strained fuel balance and the growing role of nuclear power generation, setbacks of this kind are impermissible in the future." [2]

When considering the overall primary energy production, it has to be said that the target has been missed by approx. 100 million tons of coal equivalent. A growth rate of only 2.6 percent was reached instead of an annual average of 3.6 percent as planned. Thus, production growth had again slowed down:

TABLE 2.—*Primary energy production in the U.S.S.R.*

[Annual average growth in percent]

1971-75	5.3
1976-80	4.2
1981-85	2.6
1986-90 (Plan)	3.6

This result is unsatisfactory, especially since capital expenditures for the fuel industries (crude oil, natural gas, coal) had been increased, i.e. by just over 50 percent, under the 11th Five-Year Plan as compared with the 10th Five-Year Plan. Accordingly, the share of the fuel industries in overall industrial investments rose from 21 to 27 percent.

[2] See Pravda of 4 March 1986.

The above-average allocation of investment capital for an extension of fuel production may also be seen as evidence supporting the theory that planners were disappointed by the outcome of their efforts regarding energy savings and, therefore, continued to advocate a supply-oriented energy policy.[3] This seems understandable if one takes into account that the target for energy conservation during the period 1981 to 1985 has been clearly missed: Instead of the envisaged 145 million tons of coal equivalent only 98 million tons were saved.[4]

TABLE 3.—PRIMARY ENERGY PRODUCTION IN THE USSR 1970 TO 1990

	Oil, M.T.	Gas, B.CBM	Coal, M.T.[1]	Nuclear power B. Kwh	Hyrdo-electric power, others,[2] M.T. of coal equivalent	Total, M.T. of coal equivalent
Year:						
1970	353	198	577	8	94	1,236
1971	377	212	592	8	95	1,297
1972	400	221	604	11	97	1,352
1973	429	236	615	16	96	1,420
1974	459	261	625	22	93	1,502
1975	491	289	645	24	96	1,596
1976	520	321	654	29	92	1,679
1977	546	346	663	42	99	1,763
1978	572	372	664	45	101	1,835
1979	586	407	658	55	106	1,901
1980	603	435	653	73	103	1,959
1981	609	465	638	86	109	2,003
1982	613	501	647	96	100	2,052
1983	616	536	642	110	102	2,102
1984	613	587	636	142	106	2,169
1985	595	643	648	167	110	2,232
1986[3]	615	686	675	162	110	2,330
1987[4]	617	712	670	184	114	2,372
1990[5]	635	850	715	390	121	2,666

[1] Net production.
[2] Wood, peat, shale.
[3] Provisional figure.
[4] Plan and estimated.
[5] Plan.

Source: Narodnoe Khozjajstvo SSSR; DIW data bank on CMEA energy.

TABLE 4.—PRIMARY ENERGY PRODUCTION IN THE U.S.S.R., TRENDS AND COMPOSITION, 1970 TO 1990

	Total		Share in percent					
	M. tonnes of coal equivalent	Change in percent[1]	Oil	Gas	Coal[2]	Nuclear power	Hydro-electric power	Others[3]
Year:								
1970	1,236	4.9	40.9	19.1	32.0	0.2	3.3	4.3
1975	1,596	5.3	44.0	21.6	27.9	.5	2.6	3.4
1980	1,959	4.2	44.0	26.4	23.1	1.2	3.1	2.1
1981	2,003	2.2	43.5	27.7	22.0	1.4	3.1	2.4
1982	2,052	2.5	42.7	29.0	21.8	1.6	2.8	2.1

[3] See Thane Gustafson, "Soviet Energy Policy," Joint Economic Committee, Congress of the United States, Joint Committee Print, 97th Cong., 2nd sess., December 1982 (Washington, D.C. GPO 1982), pp. 431–456.
[4] See A.A. Makarov, "Nuzhdayetsya v Sovershenstvovanii," *Energiya*, No. 4/1987, p. 22.

TABLE 4.—PRIMARY ENERGY PRODUCTION IN THE U.S.S.R., TRENDS AND COMPOSITION, 1970 TO 1990—Continued

	Total		Share in percent					
	M tonnes of coal equivalent	Change in percent [1]	Oil	Gas	Coal [2]	Nuclear power	Hydro-electric power	Others [3]
1983	2,102	2.4	41.9	30.3	21.2	1.7	2.8	2.0
1984	2,169	3.2	40.4	32.2	20.3	2.2	3.1	1.8
1985	2,232	2.9	38.2	34.3	20.2	2.5	3.2	1.8
1986	2,330	4.4	37.8	35.0	20.2	2.3	3.1	1.7
1987 [4]	2,372	1.8	37.2	35.7	19.7	2.6	3.1	1.6
1990 [4]	2,666	3.6	34.1	38.0	18.6	4.8	3.0	1.5

[1] Compared with the previous year: 1970, 1975, 1980 and 1990: average annual increase in the preceding period (1966-70, 1971-75, 1976-80, 1986-90)
[2] Net production
[3] Wood, peat, shale
[4] Plan

Source: Narodnoe Khozjajstvo SSR; DIW data bank on CMEA Energy

The Targets of the 12th Five-Year Plan (1986–90)

This thesis is also supported by the targets adopted by the Supreme Soviet in June 1986. These targets suggest that growth in the production of primary energy (fuels plus nuclear energy and hydropower) will still be clearly accelerated during the period from 1986 through 1990 (3.6 percent p.a.) in comparison to growth developments during the first half of the eighties (2.6 percent p.a.).

TABLE 5.—PLANNED INCREASE [1] OF PRIMARY ENERGY PRODUCTION DURING THE 12TH 5-YEAR PLAN PERIOD

	Coal [2]	Crude oil	Natural gas	Nuclear	Hydropower	Others	Total
Million tons of coal equivalent	46	57	246	74	10	1	434
In percent	10.3	6.7	32.2	133.5	14.0	2.6	19.4

[1] 1990 compared to 1985
[2] Net production (90 percent of gross production)
[3] Wood, peat, slate; estimated

Natural gas is to account for more than one half of the production growth. In the event of the targets being achieved, natural gas would become the most important energy source of the Soviet Union and increase its share in production from 34 percent (1985) to 38 percent (see table 4). Crude oil is to lose further importance and account for only one-third of primary energy production by 1990 (1985: 38 percent).

Chernobyl: Irritation but No Change of Course

Obviously, the Chernobyl disaster has not affected the planning for an extension of nuclear power stations. However, the chances for the implementation of the plan are meager. Just two months after the accident the Supreme Soviet decided to increase generation of atomic power from 167 billion to 390 billion kWh within 5 years. Thus, the proportion of nuclear energy in overall power generation is to rise from 11 percent in 1985 to 21 percent by 1990. In

this way, nuclear energy would account for 6 percent of overall primary energy production.

This objective would imply an extension of nuclear power capacities by approx. 40,000 MW, which means that eight 1,000 MW reactors would have to be started up every year.[5] Chernobyl has, thus, not caused a change of policy but rather some short-term irritation.

Even after the Chernobyl disaster there are mainly three reasons for the Soviet Union to expand nuclear energy:

—Nuclear power stations can be constructed in the immediate vicinity of consumption centers. The high transport costs that would be connected with the expansion of fuel extraction in Siberia will be avoided.

—Currently, nuclear energy is considered to be the only type of energy that could safeguard the Soviet Union's self-sufficient energy supply in the long run.

—There is a close interdependence between the military and civil use of atomic energy.

Besides the economic implications of the Chernobyl accident, which are broadly discussed in the contribution of Judith Thornton, three political aspects of the accident should be highlighted:

—A new course was introduced in the information policy concerning the accident. The political leadership in Moscow endeavored not to cover up the accident but to provide domestic and foreign public opinion with information that was relatively open for Soviet conditions.

—The reactions of the Soviet Union's allies were also politically noticeable. For instance, the head of the State Office for Nuclear Safety and Radiation Protection of the GDR, Sitzlack, stated in one of the first press releases after the accident: "The GDR has its own national and additional safety provisions".[6] This could also be interpreted as indirect criticism of the state of Soviet reactor safety technology.

—The Chernobyl accident has made it clear that in civil use of nuclear energy, as in military use, safety is indivisible and that there is an international community which is at risk. The Soviet Union and the other CMEA countries will continue to expand nuclear energy. By East-West co-operation the risks of nuclear energy could certainly be reduced. Existing obstacles in the field of technology transfer policy should, therefore, be reviewed critically under the aspect of whether they might eventually be counterproductive for the West.

Plan Fulfillment in 1986 and Outlook

In 1986 the production of primary energy reached the highest growth rate (4.5 percent) of the eighties. The decline in crude oil extraction could be halted and an increment of 20 million tons could be achieved. The natural gas industry surpassed the target of 672 billion cubic meters by 14 billion cubic meters.

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[5] Pravda of 5 March 1986.
[6] Neues Deutschland of 30 April 1986.

No accurate data regarding nuclear power generation are included in the 1986 plan fulfilment report. However, in comparison to 1985, a decline of only 3 percent is being shown for the atomic power industry, which would be equivalent to a production of 162 billion kWh (1985: 167 bn kWh). In view of an average capacity of 26,000 MW p.a. this would, however, mean that the nuclear power stations were operating during 6,230 hours which is equivalent to 71 percent of the maximum possible time of 8,760 hours p.a. On the whole, the production figure appears to be plausible when considering that:

—the other nuclear power stations were not switched off after the Chernobyl accident,
—the breakdown of the Chernobyl nuclear power station was largely offset by nuclear power stations that came on stream by the end of 1985 and
—load factors of over 75 percent had already been reached by Soviet nuclear power stations earlier.[7]

In the short term the consequences of the accident with regard to power supply could thus be contained. The target of 1,605 bn kWh for overall power generation has thus only been slightly missed by an output of 1,599 bn kWh. However, low water levels have also contributed to the non-fulfilment of the plan by hampering power generation in hydraulic power stations. If there have, nevertheless, been complaints in the Soviet press about bottlenecks in power supply during the winter months,[8] such shortages were probably not due to inadequate supply but rather to too high demands.

It is also remarkable that the long-lasting phase of stagnation in the coal industry appears to have been overcome. Already in 1985 the output increased by 14 million tons (gross). In 1986, the increase amounted to 25 million tons, exceeding the target of 734 million tons by 17 million tons.

Presumably, in 1985 and 1986, measures that had been taken at the beginning of the eighties to overcome the chronic production problems in the coal industry started to show favorable effects. They primarily included a modernization program for underground mines and measures for a rapid increase of open-cast production.[9]

The fuel industry—like the whole Soviet economy—appears to have substantial production reserves that can be mobilized by organizational and disciplinary measures within a short period of time. It is at least conspicuous that after the dismissal of both the oil and the coal ministers (in 1985) the respective industries reached high growth rates.

Despite the difficulties to forecast Soviet energy policy, which Jonathan P. Stern had clearly pointed out in his contribution, one can dare to predict that currently it appears by and large quite likely that the five-year plan targets for fuel production can be achieved. Capital expenditures for this industry have been considerably boosted during recent years and are also to expand above

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[7] In 1986 the nuclear power stations of the Federal Republic of Germany reached a load factor of 84 percent. See "Elektrizitätswirtschaft" No. 4/1987, page 141.

[8] Izvestiya of November 1986, Pravda of 29 September 1986.

[9] Jochen Bethkenhagen and Hermann Clement, "The Soviet Energy and Raw-Material Economy in the Eighties", Oldenbourg 1985, page 66.

average during the 12th Five-Year Plan. By their overfulfilment of the targets in 1986, the coal and gas industries have produced a comfortable cushion for themselves at least in 1987, which has become possible under the new planning guidelines. Previously, the results achieved were the basis for the targets of the subsequent year ("achieved level approach"), which reduced the industries' interest in overfulfilling the plan. In future the annual plans are to be in line with the five-year plan so that the target of the previous year and not the actual result becomes the basis for the targets of the subsequent year.[10]

The new arrangement will have the following consequence: The target of 744 million tons for coal output—i.e. 10 million tons more than had been planned for 1986—will remain 7 million tons below the result achieved in 1986. However, the coal industry, too, was explicitly invited to submit counter-plans. Taking the actual 1986 figures as a yardstick, the targets for overall primary energy production represent a growth rate of only 1.7 percent.

It cannot be expected, however, that the 1987 target and the five-year plan objective for power generation from nuclear energy will be met. Nuclear power was to account for 70 percent (223 billion kWh) of the overall growth of power generation between 1986 and 1990 (315 billion kWh), whereas hydro-power was to account for only 10 percent. Assuming half that growth rate for nuclear power, approx. 110 billion kWh would have to be provided additionally by thermal power stations. This would, however, require an additional amount of fuel in the order of 36 million tons of coal equivalent. It can by no means be excluded that at least part of it will be provided by an overfulfilment of the five-year plan targets by the gas and coal industries. But even if it will be possible to exceed the coal target until 1990, the growth in coal and nuclear energy production will not suffice to substitute for major supplies of oil.

Supply-Oriented Policy Retains Priority

In the field of energy production the targets of the 12th Five-Year Plan do not suggest any new course. However, the realization of the targets indicates some unexpected success, mainly in the coal industry. Despite considerable failures in nuclear power generation, the growth rate of primary energy production is likely to be relatively high (3.5 percent p.a.). Energy supply will, thus, hardly be an obstacle to economic growth in the Soviet Union. On the other hand, substantial investment funds will be tied up by this "growth policy".

By the relatively high growth targets for primary energy production and the above-average allocation of funds to the fuel sector the Soviet Union has indicated that it intends to continue its supply-oriented energy-policy. This is astounding considering it has been emphasized time and again that the expenditures for energy savings measures are one-half to two-thirds lower than the costs of a corresponding growth of energy production.[11] If there has, never-

[10] Pravada of 18 November 1986.
[11] See Moskovskiye Novosti of 21 October 1984.

theless, been no change towards a demand-oriented energy policy, this may be due especially to the following reasons:

At least until the adoption of the 12th Five-Year Plan, Soviet planners advocated the—certainly realistic—assumption that in the Soviet economic system a supply-oriented strategy had better chances of materializing. Increases in production can be achieved by concentrating funds on only a few investment objectives. A strategy of saving energy, on the other hand, requires a multitude of decisions concerning R&D, capital expenditures and organizational changes that have to be taken primarily at decentralized levels. There were too few incentives for this approach in the Soviet Union's former economic mechanism.

The "radical reform" of this economic mechanism as called for by Gorbachev is to largely overcome such shortfalls.[12] By greater application of indirect management methods and an orientation to profits, enterprises are to be motivated to make an economical use of inputs. However, whether this will lead to greater efforts to save energy is not at all certain. Saving successes can only be achieved if the economic leadership can make up its mind to increase energy prices drastically. However, this decisive prerequisite for a new course in Soviet energy policy is still missing.[13]

TABLE 6.—PRIMARY ENERGY CONSUMPTION IN THE U.S.S.R., TRENDS AND COMPOSITION, 1970 TO 1985

	Total [1]		Share in percent [2]					
	M tons of coal equivalent	Change in percent [3]	Oil	Gas	Coal	Nuclear power	Hydroelectric power [4]	Others [5]
Year:								
1970	1,084	4.8	34.4	21.7	35.1	0.3	3.6	4.8
1975	1,377	4.9	37.8	24.1	30.9	.6	2.7	3.9
1980	1,650	3.7	38.8	27.5	26.5	1.5	3.3	2.5
1981	1,679	1.8	38.6	28.5	25.2	1.7	3.3	2.8
1982	1,729	3.0	37.6	30.2	25.1	1.8	2.9	2.5
1983	1,779	2.9	36.6	31.7	24.5	2.0	2.9	2.4
1984	1,858	4.4	35.0	33.6	23.5	2.5	3.2	2.1
1985	1,927	3.7	33.4	35.6	22.9	2.9	3.2	2.0

[1] Including changes in stock.
[2] Excluding changes in stock.
[3] Compared with the previous year. 1970, 1975 and 1980: Average annual increase in the preceding period (1966-70, 1971-75, 1976-80).
[4] Including net export of electricity.
[5] Wood, peat, and shale.

Source: Narodnoe Khozjajstvo SSSR; DIW data bank on CMEA energy.

[12] "Economic Reforms in the USSR: State and Perspectives", adapted by Ulrich Weissenburger and Heinrich Machowski, Wochenbericht des DIW, No. 9/1987.

[13] According to Soviet sources the actual costs for fuel production are by far higher than their respective prices. As far as gas and oil are concerned costs are 2 to 2.5 times higher than prices, in the case of coal the factor is 2.5 to 3 and more. See A.A. Makarov, "Nushdayetsya v sovershenstvovanii," *Energiya*, No. 4/1987. p 22.

TABLE 7.—ECONOMIC GROWTH AND PRIMARY ENERGY CONSUMPTION IN THE U.S.S.R.

[Average annual change in percent]

	PEC [1]	PNI [1]	IP [1]	Elasticities [2]	
				PEC/PNI	PEC/IP
1975/70	4.9	5.7	7.4	0.86	0.66
1980/75	3.7	4.3	4.4	.86	.84
1985/80	3.2	3.6	3.7	.89	.86

[1] PEC = primary energy consumption; PNI = produced national income; IP = industrial production.
[2] Ratio of growth rates.

Source: Narkhoz SSSR, DIW data bank on CMEA energy.